Electrical World

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Outstanding Aspects of the Industry

PREDICTIONS and predilections for 1920 have in most cases merely served to confound the prophets and cast doubt on the wisdom of the economists. Starting out happily and heavily laden, with bunkers filled to overflowing and with every prospect of a successful voyage, the ship, badly battered, was just about able to make port. In a wide range of industries deflation has set in, and there have been perceptible slumps in the wool, cotton, grain, iron, leather, sugar, rubber, coffee, lumber and other markets. The electrical industry has not shared their fate and has hardly felt the hand of depression, chiefly for the reason that it has never been in the hands of opportunists. As one manufacturer has aptly expressed it, "Furnishing both material and brains, it has sold the material and given away the brains. Seemingly satisfied with the creation of great wealth for the community, it has reserved for itself but a fraction of what it created." It has therefore enjoyed a gradual growth with medium prosperity, which gives it a position of stability and renders it more or less panic-proof.

ENGINEERING developments during 1920 kept pace with the needs of the country. It is difficult to improve the already high efficiency of most electrical apparatus. Improvements, therefore, have for the most part been along economic rather than technical lines, except in the radio-telegraph field. Interconnections of electric generating and distribution systems continue to grow, and transmission voltages as high as 220,000 are planned. Recent legislation has given impetus to water-power development, and high-pressure steam stations established at mines, wherever feasible, are coming into vogue. Official studies are also under way for super-power zones which are fraught with great economic possibilities. These developments, however, are evolutionary rather than revolutionary. There is growing appreciation on the part of engineers of their duty to the public, and this has led to the formation of the council of the Federated American Engineering Societies, whose function it is to develop this national sense of engineering and its relations to our great human problems.

THE constant growth in output of the electric light and power companies of the country despite the many and serious obstacles which have confronted them during the past year is the best evidence of the proficiency which characterizes the operation of these public utilities. Of itself this should be a matter of pride to the entire engineering profession; yet, great as is the accomplishment, greater still is the fact that the average cost of electricity remains, as it has remained during the past decade, almost constant. This is phenomenal and indicates the immense possibilities within the industry when better regulatory policies and practices shall unshackle and stimulate the genius and ability of all public utility men.

FINANCIAL problems still overshadow the electrical central stations. The needs for new capital are exceedingly great and the acquisition of it is difficult. Permits for water-power development alone, if they are granted, will tax the ingenuity and skill of manufacturers, executives and operators alike, for they involve 12,000,000 hp. and the expenditure of approximately $2,000,000,000 over and above the normal outlay for improvements and betterments to existing generating and distributing systems. During 1920 about $400,000,000 of new money was raised by electric public utility companies for refunding and other purposes incident to the well-being and expansion of the business. That the amount was insufficient goes without saying—twice that sum could have been used. The outlook for an easier money market, however, is bright, and with the inducements which low-priced public utility securities offer for a fairly high yield more funds will be available.

THE country is suffering somewhat from an embarrassment of riches. We have been blessed with crops of wheat, corn, cotton and other staples more abundant than ever. The best record of the feverish war days has been surpassed by the steam railroads. Our foreign trade has reached an enormous total, establishing not only a new record for the nation but constituting the greatest volume of trade ever attained by any country in any age. What though there be stagnation here and there, it is not symptomatic of the country or of the electrical industry. The world is short of material, and, considering the industrial dislocation occasioned by the war, the derangement of finance, the colossal government debt and other disturbing influences, the natural forces now in operation are not only reassuring in their reactions but are conducive to business stability. It would have been too much to expect that the electrical industry would not respond sympathetically to the fluctuations occurring in other basic industries. Even with the declining business of the past four months the record for the year exceeds by at least 25 per cent the business of 1919 and our factories are still working on unfilled orders. However, the period of readjustment has about run its course and within the next few months it is reasonable to expect an expansion of business that will make all past predictions seem conservative. Factors in this coming expansion are already beginning to appear.

Guy Eastman Tripp

One of the outstanding captains of the electrical industry, an organizer and administrator whose leadership and judgment are frequently sought

SOME men contribute to the advancement of an industry through their research, others through their engineering skill, but there is one small group that makes it possible for the public to enjoy fully the benefits of the vision, skill and brains of the others. To this group belong the executives who direct and guide industrial progress. On such men rests the responsibility for the future development of the electrical industry. No matter how carefully a motor has been designed nor how substantially a dam has been built, the necessary confidence of the public is wanting unless there is a leader at the head of the enterprise. Such a man is Guy E. Tripp, chairman of the board of the Westinghouse Electric & Manufacturing Company. With the Stone & Webster organization, later in the almost hopeless task of reorganizing the badly muddled affairs of the Metropolitan Street Railway system, then as chairman of the board of the Westinghouse interests, and during the war chief in charge of production of ordnance, he has always been able to shake off details, get at the meat of the problem and arrive at a solution which assures success.

As a traveling auditor with Stone & Webster Mr. Tripp attracted such attention that he was soon managing utility properties and divisions and finally became a vice-president. While with Stone & Webster he was appointed chairman of a committee of three to operate the New York City railways, then under receivership. His conspicuous work in that capacity came to the attention of the directors of the Westinghouse company, and after the death of Mr. Mather Mr. Tripp was appointed to his present position. He went to that company while it was emerging from the trials of its receivership at a time when it needed a financier and a student of human nature, with a firm hand and a clear insight, to keep its course straight in the channel of healthy business. How well he has succeeded can be judged from the strong financial position of the company, which in the current fiscal year expects to bill in the neighborhood of one hundred and seventy-five million dollars' worth of goods.

Mr. Tripp was born April 22, 1865, at Wells, Maine, and started to work when a boy. He has achieved success wherever his endeavors have led him because he has mastered the job and stuck to the essentials. When he became an executive he left the details to others, placing responsibility on subordinates and expecting and getting results. He has the faculty of harmonizing conflicting interests and of getting to the heart of things by the most direct route. In the Ordnance Department, where he attained the rank of brigadier-general, he astonished all by the ease with which he cut red tape, decentralized the department and produced results. For his services in this connection the General has been decorated with the distinguished service medal of the United States government.

The Electric Public Utility Outlook

Necessity of Raising Huge Amounts of New Capital Still a Pressing Problem—Millions of Water Horsepower Awaiting Development—Spirit of Good Will Toward the Industry Manifested

By MARTIN J. INSULL
President of the National Electric Light Association

THE year just begun is full of promise for the electric light and power industry. The possibilities will be markedly determined by the degree to which we are able to finance ourselves. For the public good it is expedient that light and power companies be made to function efficiently and be put on a paying basis. They must have adequate equipment and funds for expansion to meet the growing needs of the communities they serve, and their securities must be made attractive to the small investor.

SMALLER INVESTORS DESIRABLE

Large investors, that is to say people with wealth, are not in the market at the present time by reason of the fact that, owing to the very heavy supertaxes on incomes, they feel they can better afford to buy tax-free securities paying a low rate than to take on investments yielding a higher rate but actually producing less on account of taxes. Therefore the investors that we as utility men must rely on more and more are the smaller ones. We must interest them not only as possible suppliers of funds but also as a matter of sound public policy. For that reason the campaigns of good will entered into most generously by the manufacturers of electrical apparatus and supplies and by the National Electric Light Association and other kindred utility organizations ought to go far in building up faith in public utilities and in establishing the indispensability of their service.

NEED OF FURTHER DEVELOPMENTS

Any electric light and power company is worth to the community what it can give it in service. If the utilities are short of equipment or otherwise crippled in distributing electricity the problem is the community's as well as ours. The cost of our inability to render adequate service falls directly on the public.

The electric light and power companies of the country would like to buy more equipment. They need it just as really as the thousands of industries in communities they serve require the electricity that would be generated by it. In addition, vast water powers made available for development by congressional action will require millions of horsepower of apparatus, costing billions of dollars, before the energy of the falling water can be made serviceable to mankind. But with the money market as it is at present, and with existing credit restrictions, the industry is not in a position now to command the funds with which to buy all the equipment it needs unless the public service commissions of the several states permit it to earn more on its present investment.

Of course, public utility managers must show inherent ability and must breathe the spirit of service, but they cannot accomplish the impossible. What they have done in conjunction with their efficient and loyal organizations against heavy odds has been nothing short of marvelous, and it is only just that the public be apprised of the accomplishment.

SERVICE ESSENTIAL TO INDUSTRY

Electric utilities today are vitally essential to the industrial world. Once they were developed beyond the demands on them, but now they cannot meet the offered loads. It is unthinkable, however, that industrial expansion should be checked by lack of electrical facilities. Our power systems will be improved and increased to be adequate to the growing demands of industry. With all the handicaps that have confronted us during 1920, the electric public utilities have produced eight billion kilowatt-hours more energy than they did in 1919 and raised almost half a billion dollars of new money. I submit, therefore, that the electric light and power industry has done, as it will continue to do, its best in serving the country. However, it will need more than ever before the co-operation of the public and the unanimous support of the other branches of the industry.

PUBLIC UTILITY SECURITIES SOUND

The job before us is to educate the smaller investor to put some of his savings into public utility securities. This is ethically just and practically wise from every angle. The movement is, moreover, timely, for never so much as now has there been need of disabusing the American people of their old notions concerning capital generally, and particularly concerning capital invested in the securities of electric light and power companies, regulated as they are by public service commissions and conducted for the public good by men of broad experience and technical skill.

SPIRIT OF GOOD WILL MANIFEST

Already a new spirit toward the electric public utilities is manifesting itself on the part of bankers, public service commissions, business men and the public, and I cannot urge too strongly that we as utility men acquit ourselves as deserving of the confidence and trust thus reposed in us, and that we be imbued and animated by the spirit of service, sufficient and unsurpassable, so that ours shall be the model public utility—young, lusty, enterprising, intrepid, daring and resourceful. That has been our heritage and the basis of our marvelous growth. The least we can do is to pass it on with added honors and luster.

APPEAL TO PUBLIC OPINION

Our appeal lies in a dignified submission of the case to the public will. Provided that that public is properly informed and enlightened, either through our own efforts or the efforts of our friends, our future is secure. That consummation, I am reasonably certain, we shall experience in large measure in 1921.

Interconnection Power-Contract Principles

Contracts Should Not Be Entered Into Except as New Investment Is Made, and Then There Should Be Provision for a Fair Division of Revenue

BY R. S. HALE
Superintendent Special Research Department, Edison Electric Illuminating Company of Boston, Mass.

ELECTRIC power is sold over transmission lines connecting the systems of different companies in two cases. The first case is where the lines are built and ready so that there is no problem of capital expenditure. This condition may be brought about in several ways. Sometimes an old contract has expired, sometimes the capital expenditure is so small that it is disregarded, and sometimes the two companies have got together and said: "Let us make this connection. One of us will build so much and the other will build so much, and then after we have made the connection we will see what we will do about buying or selling energy."

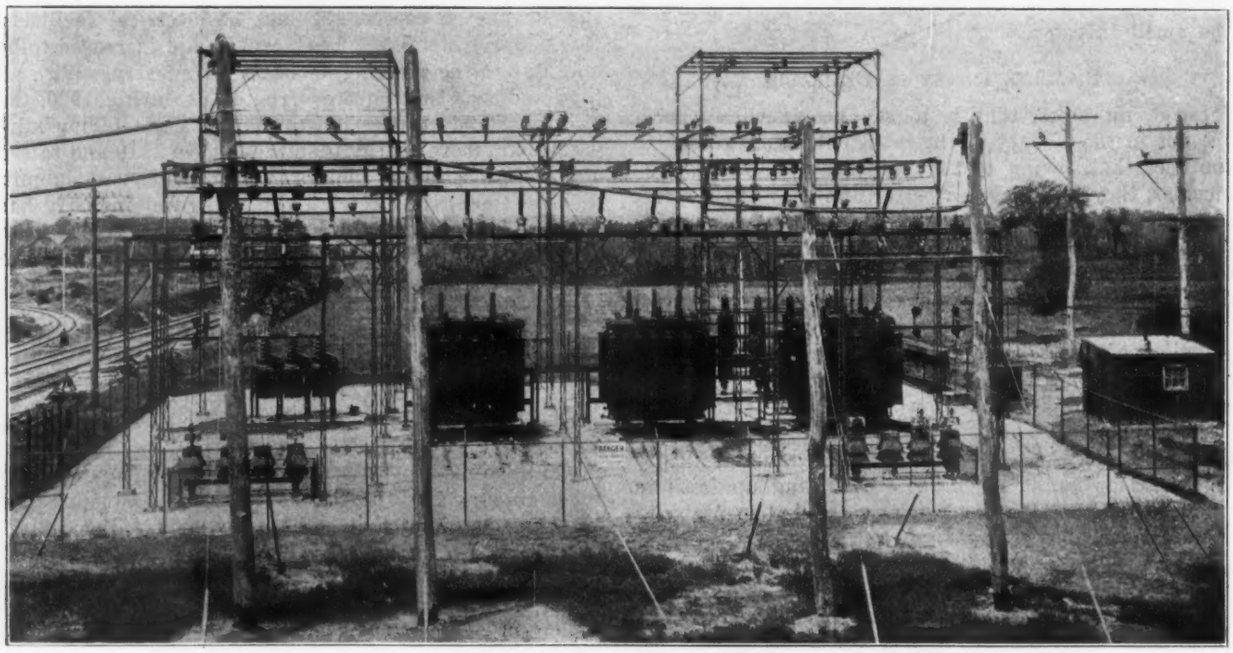
In all these circumstances the best advice in regard to making a contract is the same as the advice of *Punch* to those about to marry: "Don't." The best contract is no contract at all. Let each company state the price at which it will sell, the statement of the price also including the time at which the supply will be available, the amount, and any further requirements as to power factor, load factor or anything else. The price, however, would be subject to change at any time, or perhaps the selling company would say: "This price will stand for a week or a month or a year so that the purchasing company can plan ahead." The prices and conditions, however, would be settled by the selling company and would not be a contract in the ordinary sense of the word, but would be a rate or set of rates.

For instance, the selling company might say:

"The rate is 1 cent, and we can supply up to 5,000 kw. except between 2 p.m. and 6 p.m. If you take only 500,000 kw.-hr. per month or less, there will be no reduction, but for more than 500,000 kw.-hr. per month the rate for the excess will be 9 mills. If you want energy between 2 p.m. and 6 p.m. we can give you 1,000 kw., but you must give us two days' notice so that we can get the boilers ready, must pay us $50 per day extra and must pay an extra half cent for energy taken during those hours."

The selling company could put out rates like these or others with more or less complications and could change them from time to time; but unless there is involved an expenditure for other than operating expenses, what is the need of a contract?

If, however, and this the second case, an expenditure of new money for capital account is involved, then the investing company may feel it necessary to have some agreement so that it may not be left with an idle investment. The principle and practice involved here is much the same as with ordinary sales of power in the cases when an investment is needed. One company makes an investment in hope of selling enough energy to make it a paying one. The company may be and often is willing to "take a chance" without a contract; but, if unwilling to take the risk, what form of contract should it make?



TRANSFORMER STATION WHICH CONNECTS BOSTON EDISON AND NEW ENGLAND POWER COMPANY'S SYSTEMS
During year ended June 30, 1920, the former company sold to the latter 11,560,822 kw.-hr. and purchased in exchange 7,125,257 kw.-hr.

A committee of the National Electric Light Association once made a report on this subject and suggested the following scheme as fully protecting both parties:

Let the purchasing company advance the money and let the investment made with that money become the property of the selling company but be earmarked during the term of the contract for the use of the purchasing company. In the ordinary case of sales of primary power this is accomplished by specifying a number of kilowatts (or kilovolt-amperes) always to be available. In the case of secondary power it would be accomplished by specifying a number of kilowatts to be available for the use of the purchasing company during all except peak hours, which would be defined by the clock or

might be defined by permitting the selling company to shut off, say, 500 or 800 or some other number of hours per year as chosen by itself.

The rate paid for energy taken should be the regular rate that the selling company would charge for energy delivered with its own investment in its own territory, but the money thus paid should be separated into two portions in some defined way, the first portion corresponding to operating expenses and to be retained by the selling company, and the other portion corresponding to the return on the investment and profit, to be returned by the selling company to the purchasing company until the money advanced for the investment shall have been returned with interest. The agreement should be subject to arbitration if circumstances change, and the rate for the power, which would not be in the contract but would be established by the selling company, should also be subject to arbitration.

Such an arrangement absolutely protects both companies, because if no energy is used the selling company has not had to expend any of its own funds since the purchasing company advanced all the money for investment, and as no energy is used there are no operating expenses.

If, on the other hand, energy is used, the selling company has to provide money for operating expenses, but this is covered by the portion of the bill retained, while the balance is returned to the purchasing company until the money advanced is returned with interest.

Theoretically such a contract might be for an indefinite time, since even if the investment was never returned the selling company would in theory still be safe. Practically, however, it seems more reasonable to provide that at the end of say seven years no further return of investment shall be made, but thereafter all the money paid for power shall be retained by the selling company. In any case the total rate for the power should be the regular rate of the selling company, the same as charged in other cases under similar conditions, and should be subject to change by arbitration and not be a part of the contract.

If it is a question of financing, the purchasing company, instead of advancing cash, can provide notes or bonds, which the selling company would place in its treasury. The money returned by the selling company to the purchasing company would then be available for paying the interest and principal on these bonds.

While this is a perfect method, it is not yet in use. Instead, most contracts call for a guarantee, either in dollars or in kilowatt-hours, and such contracts usually work well. If, however, there is any real danger that the purchasing company will not use enough to fulfill its guarantee, then there should be a provision so that the penalty or price paid for the amount not taken under the guarantee would be less than the full rate for energy actually taken, since the selling company would save operating expense on all energy not taken.

In any case the rate for energy should not be part of the contract, but should be subject to change from time to time, with provisions for arbitration—or, what is the same thing, subject to appeal to a utility commission.

In any case contracts should be for as short a term as is considered safe. Short contracts make for long friendships, and even if a capital expenditure is involved, both parties should look forward to getting as soon as possible on the basis of no contract, but selling and buying power at rates according to the existing conditions and subject to revision when conditions change.

Tendencies in the Design of Power Stations

Economies Resulting from the Skillful Arrangement of Station and Layout of Equipment and Operating Tendencies in Boiler and Turbine Rooms

BY PETER JUNKERSFELD
Engineering Manager Stone & Webster, Inc., Boston

THE present and probable future economic condition of the world indicates that greater advances in the field of power-station design are to be expected in the coming years than in those just past. During the last few months the necessity of avoiding waste has been brought home to everybody, and it is not unlikely that economy will be a virtue for some years to come. The public service industry, in which the production of power has reached its highest development, has been restricted in the growth of its normal power supply owing to financial conditions and war-time activities. With the improved conditions, from the central-station point of view, which are undoubtedly soon to prevail, it is to be expected that many additions will be made to present power stations and that a number of new plants will be built. There will then exist the great stimulus to progress—the need for improvement and the opportunity to get it.

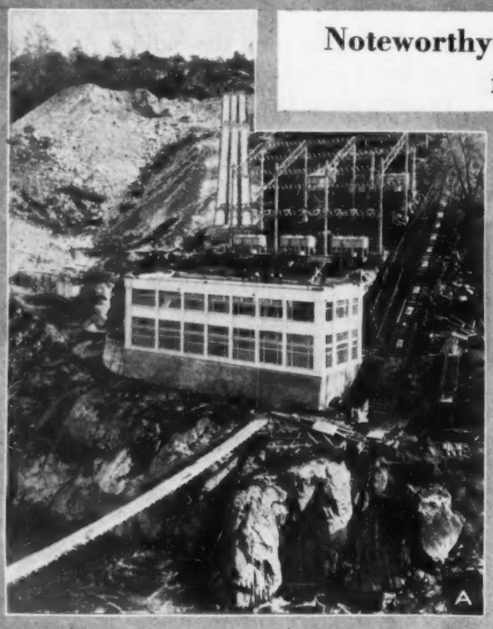
I do not wish to imply that the past year or two have been entirely devoid of progress, for there has been a steady advance to better practice and much thinking as to what will be done when the opportunity offers. There has also been a severe test of equipment to furnish a basis for further progress.

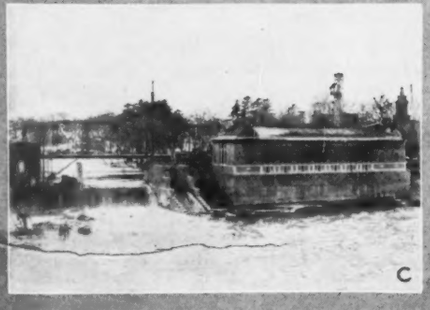
EFFICIENCY VERSUS FIRST COST

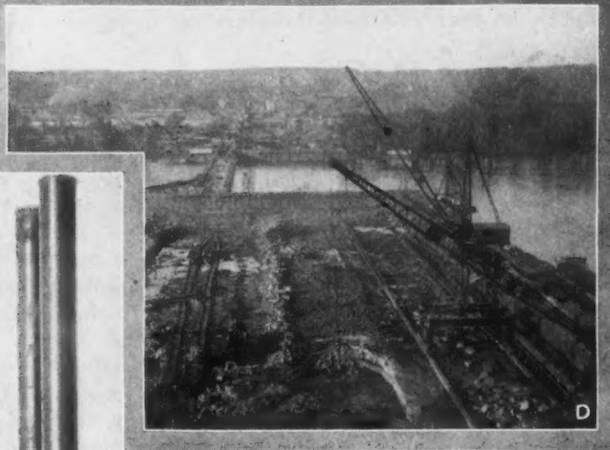
In the pursuit of the maximum of efficiency designing engineers are always held in check by the cost of reaching it. The recent extremely high price of coal has seemed to justify construction expenditures that would not be permissible with cheap fuel. However, there is always danger of regarding the present as a "normal" period and of going to great lengths to obtain low operating cost without sufficient regard to the possibility of burdening the plant throughout the future with excessive fixed charges. It is, therefore, most important that during the design period a close study of probable operating costs for a long period be made and that these be carefully balanced against the fixed charges. Low operating expense, especially in operating and maintenance labor, can frequently be obtained without additional cost by skillful arrangement of suitable building and equipment. This is something which is always in order and is receiving a great deal of attention.

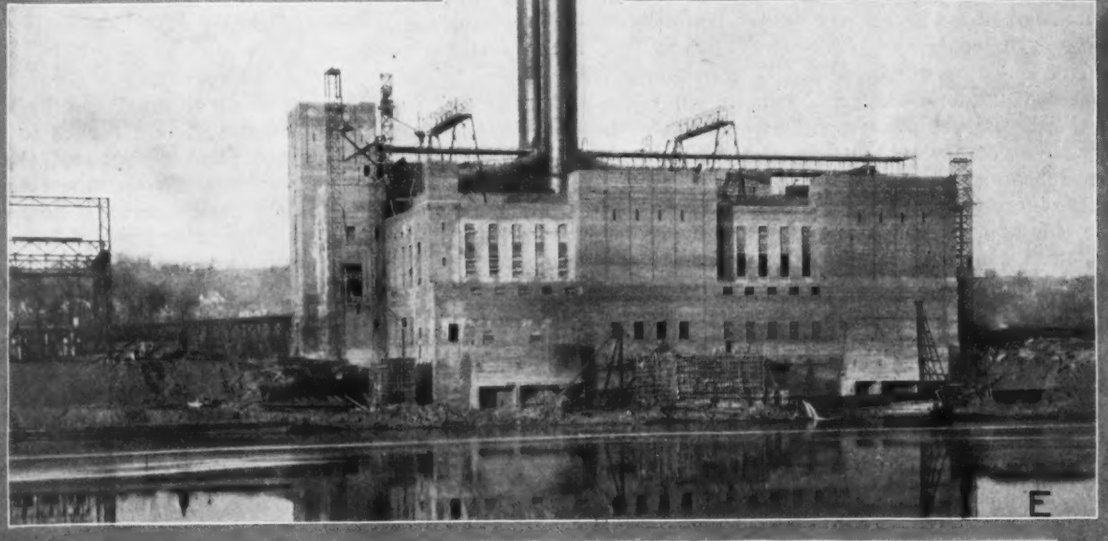
As fuel cost usually represents nearly 80 per cent of the station operating and maintenance expense, efficient boiler operation deserves great consideration. Education of the firemen, an all-important factor, is, of course, outside the province of the plant designer. He can, however, give serious study to the selection of the stoker and the design of the furnace, and he can provide suitable instruments to permit operation of the boilers on a continuous-test basis. The drift toward more general use of large boilers permits the use of instruments on individual units without seemingly prohibitive cost, and it is now becoming common to see coal actually weighed into the stoker hoppers, the feed water input and the

Noteworthy Plant Construction in 1920









A—The 60,000 hp. Kerckhoff plant of San Joaquin Light & Power Corporation, near Fresno, Cal., started Aug. 15, 1920, and completed in fifteen months at cost of about $6,000,000. B—Westport steam generating station of the Consolidated Gas, Electric Light & Power Company of Baltimore, which will have 140,000 kw. installed rating by March 1, 1921. C—Skowhegan 12,750-hp. hydro-electric plant of Central Maine Power Company, formally started Dec. 1, 1920. D—Muscle Shoals (Ala.) dam from the power-house end. The power station will have an initial installation of four 30,000-hp. I. P. Morris waterwheels driving four 20,000-kva. Westinghouse generators. The ultimate rating will be 612,000 hp. E—The Colfax station of the Duquesne Light Company, Pittsburgh. Two 60.000-kw. generating sets are installed, and four more will be added as the load increases.

steam delivery metered, and other instruments and automatic controls installed.

The design of boiler settings now receives much more study in detail than has been the practice in the past. Boilers now are usually set very high. There are several recent instances of the B. & W. type of boilers being set with the bottom of the front header nearly 20 ft. (6 m.) above the floor and the Stirling type of boilers with the center of mud drums 12 ft. and 13 ft. (3.6 m. and 3.9 m.) above the floor. The settings are constructed entirely of firebrick, and provision is made for expansion in all four walls so as to prevent cracking of the brickwork.

Underfeed Stokers of Standard Types Hold Prominent Place

Underfeed stokers of the standard types continue to hold their prominent place. In localities, however, where high-ash coals of high volatility have been burned principally in natural-draft chain grates, as in the Middle West, the demand for high capacities has led to the use of traveling grates arranged for forced draft. The Coxe stoker was already available for this service, with a successful record of many years behind it, and several other types are now on the market. There has also been a marked disposition to use forced-draft traveling grates for small-sized anthracite in regions well outside the normal anthracite area.

A decided advance has been made within the last year in the practice of burning oil fuel. The mechanical atomizing oil burner has been adapted to the needs of stationary plants, and very high capacities and efficiencies are being obtained. As much as 1,300 lb. (590 kg.) of oil can be burned per hour in an individual burner using forced draft. The intimate and exact mixture of air and oil at their point of entrance into the furnace which is required for both efficiency and capacity can be maintained over the entire range of output with much less difficulty than when steam atomizing burners are used.

Although recent conditions have been more favorable to the economizer, there has been some hesitancy about using it. Cast-iron construction under high pressure is not generally desirable, and corrosion trouble with steel tubes has been considerable. Station designers have shown a disposition to avoid these difficulties as well as much of the cost incident to a straight economizer installation by using deeper tube banks on boilers of the B. & W. type and integral economizers on boilers of the Stirling and Bigelow-Hornsby types. These devices admittedly do not recover so much heat as a true economizer, but appear to be very satisfactory compromises.

Station Heat Balance

Obtaining a satisfactory heat balance in a steam-power station is always an important problem. It is just as important, however, that considerable flexibility be permitted so that the operator may maintain the balance under wide variation of load. Much ingenuity has been displayed in the various solutions of this problem. The use of house turbines and alternate steam and motor drives is well known. Plans have lately been devised for bleeding steam from the lower stages of the main unit, after it has done a maximum of work, and using it for primary heating of the condensate returns. This has the effect of retaining within the heat cycle of the plant some of the heat otherwise wasted in the condensing water, with corresponding gain in plant efficiency. Heating of the water is completed by the exhaust from a house turbine or other auxiliaries.

Power-Station Buildings

In the design of power-station buildings there have been noticeable tendencies toward deeper basements in both turbine and boiler rooms. In the former the turbine floor partakes of the nature of a gallery around the turbine, permitting the access of light and air to the condenser floor and an easy view of all operating equipment. The high boiler-room basement permits discharging ash directly from the hopper into standard railroad cars or motor trucks and greatly simplifies the problem of ash removal. In the boiler room coal bunkers are now frequently built at one end or in the center, the stoker hoppers being filled by traveling weigh lorries. This leaves the space over the firing aisle free and permits natural lighting and ventilation.

Condensation in the winter time on the underside of the turbine-room roof, which has long been a cause of trouble to plant operators, is also receiving further attention.

Station Electric Equipment

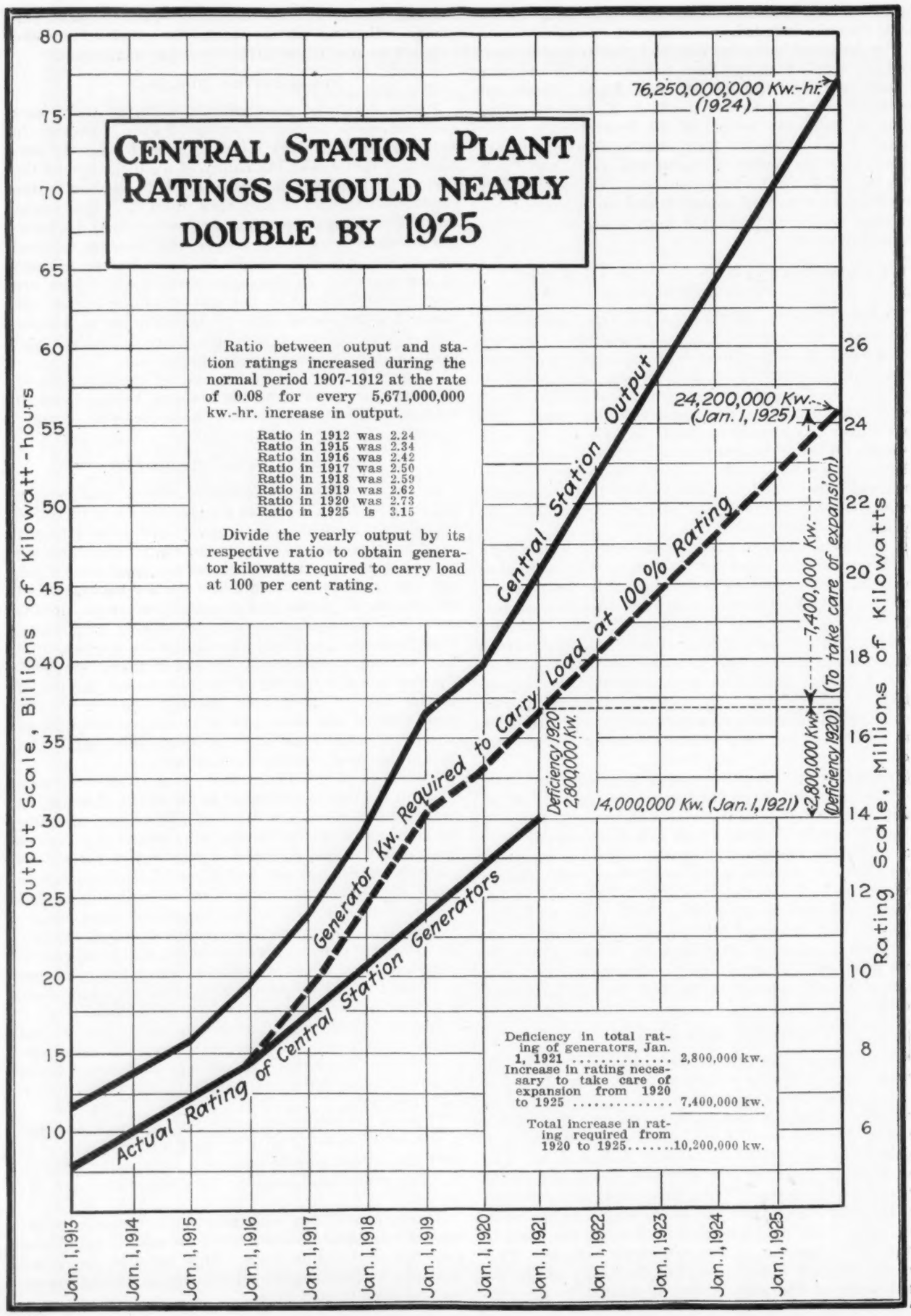
In the layout of the electrical side of the modern plant the tendency is toward simplification and increased reliability. Switchboards are arranged more logically in order to prevent trouble due to mental errors on the part of operators. Bus structures are made more rigid, and the tendency is toward the greater separation of the phases, to reduce the possibility of short circuits as well as the mechanical stresses arising from them. With these ends in view bus insulators are placed so that they will be in compression instead of tension or bending, and a wider spacing of conductors and the use of heavier barriers have been adopted. In one or two cases each of the three phases is being housed in an entirely separate room with the single-pole switches of each circuit tied together mechanically.

Avoidance of the destructive effect of short circuits is one of the things uppermost in the minds of designing electrical engineers. Switches of higher current-carrying and rupturing capacity are being employed. Various weak points of the electrical system within the station are being strengthened, resistance is being placed in series with potential transformers to limit flow of current to a short circuit within the transformer, single-turn current transformers are being employed to avoid the failures common with other types, and more care is being exercised in the selection of taps and connections on account of the frequency with which they have been destroyed by short circuits.

The use of reactors in generator leads, between bus sections and in outgoing feeders, is receiving much more attention to insure their satisfactory functioning under short-circuit conditions without interference with normal operation.

There is a tendency to return to automatic switches in generator leads but with the relays so arranged as to open the switch only in case of a short circuit within the generator, thus cutting the disturbance off the system.

All equipment that will operate satisfactorily in the open is being placed outdoors for the sake of safety and reduction in building costs. This includes power and instrument transformers, oil switches, lightning arresters and high-tension buses.


CENTRAL STATION PLANT RATINGS SHOULD NEARLY DOUBLE BY 1925
Ratio between output and station ratings increased during the normal period 1907-1912 at the rate of 0.08 for every 5,671,000 kw.-hr. increase in output.
Ratio in 1912 was 2.24
Ratio in 1915 was 2.34
Ratio in 1916 was 2.42
Ratio in 1917 was 2.50
Ratio in 1918 was 2.59
Ratio in 1919 was 2.62
Ratio in 1920 was 2.73
Ratio in 1925 is 3.15
Divide the yearly output by its respective ratio to obtain generator kilowatts required to carry load at 100 per cent rating.
76,250,000,000 Kw.-hr. (1924)
Central Station Output
24,200,000 Kw. (Jan. 1, 1925)
Generator Kw. Required to Carry Load at 100% Rating
7,400,000 Kw. (To take care of expansion)
Deficiency 1920 2,800,000 Kw.
2,800,000 Kw. (Deficiency 1920)
14,000,000 Kw. (Jan. 1, 1921)
Actual Rating of Central Station Generators
Deficiency in total rating of generators, Jan. 1, 1921 ..... 2,800,000 kw.
Increase in rating necessary to take care of expansion from 1920 to 1925 ..... 7,400,000 kw.
Total increase in rating required from 1920 to 1925 ..... 10,200,000 kw.
Output Scale, Billions of Kilowatt-hours
Rating Scale, Millions of Kilowatts
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
26
24
22
20
18
16
14
12
10
8
6
Jan. 1, 1913
Jan. 1, 1914
Jan. 1, 1915
Jan. 1, 1916
Jan. 1, 1917
Jan. 1, 1918
Jan. 1, 1919
Jan. 1, 1920
Jan. 1, 1921
Jan. 1, 1922
Jan. 1, 1923
Jan. 1, 1924
Jan. 1, 1925

Electrical Industry Will Require $10,371,000,000 for New Plants and Appliances by 1925*

PROBABLE INCREASE IN GENERATOR RATING OF WATER-POWER PLANTS

	Kw.
Water-power development probable on government land, navigable streams and boundary waters (present Federal Power Commission Applications), between the years 1920 and 1925	7,500,000
Water-power development probable on non-navigable streams not on government land (assumed as 10 per cent of that under Federal Power Commission)	750,000
Total water-power development probable between 1920 and 1925	8,250,000

The total power applications at present before the Federal Power Commission total about 10,000,000 hp., or 7,500,000 kw., and this figure has been taken as the probable hydro-electric development in the next four years. In plotting the "central-station output" curve to be found on the opposite page no account has been taken of possible large consumption of electrical energy by industries not now existant, such as new irrigation projects and electrochemical developments, practically all the energy for which will be produced by hydraulic plants. The estimated consumption and the generator rating by 1925 are believed to be conservative.

* * *

PROBABLE INCREASE IN GENERATOR RATING OF STEAM-POWER PLANTS

	Kw.
Total increase in central-station generator rating required by 1925 (see curves)	10,200,000
Central-station probable hydro-electric development by 1925	7,750,000
Probable increase in central-station steam and gas plants by 1925	2,450,000
Private hydro-electric developments by 1925	500,000
About one-third of private plants assumed hydraulic; therefore private steam electric developments by 1925	1,000,000
New central-station steam plants plus new private steam plants	3,450,000

Although the number of water-power permits under consideration indicates that hydro-electric development for the next five years will be of the order given in our estimate, a definite ratio between steam rating and hydro-electric rating has been found essential. Therefore, if the water-power rating which is tabulated is installed, more steam rating will have to be provided as reserve. However, increasing interconnection of electric service systems may reduce the ratio of steam reserve to hydro-electric rating below what is now considered necessary.

* * *

HYDRO-ELECTRIC DEVELOPMENT COSTS

Cost of new generating-plant capacity—8,250,000 × $200	$1,650,000,000
Cost of transmission equipment—8,250,000 × $110	907,000,000
Cost of distribution installation—6,120,000 × $100	612,000,000
Cost of customers' lamps, motors and appliances and of wiring houses and factories—6,120,000 × ($125 × 6)	4,580,000,000
Total capital required for probable hydro-electric developments and resulting service costs	$7,749,000,000

Since 2,800,000 kw. of the 10,200,000 kw. (required new installation for central stations) is to displace present generator overload, that amount will not call for additional transmission or distribution systems and will not supply energy for additional motors, lamps or appliances. Therefore, only 5,620,000 kw. of new central-station hydraulic-plant installation will call for additional distribution system or will supply energy for additional motors, lamps or appliances, and only 1,780,000 kw. of new central-station steam-plant installation will call for additional distribution system or will supply energy for additional motors, lamps or appliances.

* * *

STEAM-ELECTRIC DEVELOPMENT COSTS

Cost of new generating-plant capacity—3,450,000 × $75	$259,000,000
Cost of distribution system—2,780,000 × $100	278,000,000
Cost of customers' lamps, motors and appliances and of wiring houses and factories—2,780,000 × (125 × 6)	2,085,000,000
Total capital required for probable steam-electric developments and resulting service costs	$2,622,000,000

As a basis of arriving at costs pre-war or 1912 prices have been used in the following computations.

A study of cost data available indicates that the cost of steam-electric generating plants under 10,000 kw. rating in 1912 averaged about $102 per kilowatt and that plants over 50,000 kw. averaged about $70 per kilowatt. The figure of $75 per kilowatt has therefore been adopted in these computations for steam-electric plants, since most new plants will probably be of large capacity. Cost of hydro-electric plants varies over a wide range. The small plants of this type averaged in 1912 from about $150 to $300 per kilowatt, and the large plants averaged around $140 per kilowatt, although large plants without dam and reservoir construction ranged as low as $85 per kilowatt. The figure of $200 per kilowatt has been adopted in these computations for hydro-electric plants. These plant costs have been, as far as possible, based on rock-bottom prices and do not include highly developed architectural plants. Cost of transmission equipment has been assumed as $110 per kilowatt, and cost of distribution installation has been assumed as $100 per kilowatt. The cost of wiring houses and factories and the cost of motors, lamps and appliances needed by customers has been assumed in the aggregate as $125 per kilowatt, with a diversity factor of six, giving the capital required to supply customers' needs as $725 per generator kilowatt.

* * *

SUMMARY OF NEW CAPITAL NEEDED (1920 TO 1925)

Capital for new generating-plant capacity—$1,650,000,000 + $259,000,000	$1,909,000,000
Capital for new transmission equipment (hydraulic plants only)	907,000,000
Capital for new distribution equipment—$612,000,000 + $278,000,000	890,000,000
Capital for customers' lamps, motors and appliances and for wiring houses and factories—$4,580,000,000 + $2,085,000,000	6,665,000,000
Total new capital required by electrical industry, 1920 to 1925*	$10,371,000,000

*Exclusive of electric railroads, street railways, telephones and telegraphs.

Automatic Financing

A New Form of Public Ownership, Sustained and Encouraged by Self-Interest, Enables Electrical Utilities to Obtain Required Funds as Needed

BY R. H. BALLARD
Vice-President and General Manager Southern California Edison Company

BEHIND the new financing of electrical utilities is the ever-broadening knowledge of the American people that their present prosperity and the future achievement of their children and their children's children are absolutely dependent upon the development of the electrical resources of the nation. It is well that this is so, because with the rapid depletion of the reserve of timber and mineral fuels a climax in the world's history has been reached and a change is foreshadowed in the prime mover of industry, agriculture and transportation which is so comprehensive as to require enthusiastic and patriotic co-operation in its financing.

The conditions under which an electric light and power company can operate approach the ideal in almost exact ratio with the proportion of the company's equity owned by its consumers. This view, carried to its logical conclusion, would place the ownership and control of the company in the hands of those who depend upon it for service and look to it for the development of their lands, for the growth in population of their towns and cities and for increase in their own business. It stimulates the self-interest thought of community expansion and individual profit and makes it possible for the operating company to finance 25 per cent of its development by the sale of junior securities to its patrons, and then go into the recognized money market for 75 per cent on bonds and mortgages.

State regulation has taken the securities of public utility companies out of the speculative class, and they are gradually taking their place in a class with municipal securities. They can be issued only by an order of the regulating body, upon a basis of actual plant investment. There is, however, a growing belief that regulation, if carried to the extreme of limiting return to a point below the market price of money and forbidding any possibility of profit as a reward for enterprise, economy and efficiency, would become a steam roller, crushing out that vital thing in all human endeavor—initiative—and reducing investment and effort to a dead level. In the human equation there is no such thing as the status quo. There must be room for hope and optimism, else the stagnation and apathy which result from bureaucratic management such as obtains in Europe will produce the natural fruitage of apathy and sullenness, which we have seen break forth in insurrection, revolution and anarchy.

Five hundred million dollars will be needed in California within the next ten years for new power development. Basing its opinion upon the reports of the several companies operating in the state, the Railroad Commission finds that this great sum will be needed for producing and distributing 1,750,000 hp. of additional electrical energy.

While the financing of electric public utilities during the past year or two has been difficult because of enforced competition in the money market with large industrial offerings and foreign securities, development has gone forward in California which will result in bringing in 250,000 hp. of additional hydro-electric energy during the year 1921. Through the summer of 1920 a serious power shortage was threatened, but the great hydro-electric development of the past year seems sufficient to avert a recurrence of the shortage in 1921, and it is believed that with better financial conditions water-power resources can be developed with sufficient rapidity to meet the requirements.

The gasoline shortage, the fact that coal is not commercially available in California, the diminishing oil supply with the consequent increase of price, and the necessity of devoting the entire natural-gas supply to domestic uses, have brought home to the people the imminent necessity of developing the water-power resources of the mountain ranges. The need for co-operative effort along this line is being expressed by the press and on the platform in the manner characteristic of a great public movement. The methods followed by operating companies in financing these large developments are generally similar. Bonds are issued for approximately 75 per cent of the cost, and these bonds are sold to large banking syndicates for resale and distribution to the public at large throughout the whole country. The remaining part of the cost is provided by the sale of junior securities to the California public, and these stocks are being rapidly absorbed by investors, consumers and by officers and employees of the operating companies themselves. They form a splendid basis for accumulated savings. Success in distributing this form of securities among the people of the state has already been phenomenal, but a well-founded belief prevails that the movement is only in the stage of inception and still wider distribution is anticipated.

OPPORTUNITY FOR CONSUMER TO BECOME OWNER OF SECURITIES

It is an ownership by the people in the securities of their own regulated companies, and it not only retains the ownership of utilities in the community but insures to the enterprise the trained experience of those eminently fitted to perform the task. As contrasted with the old and now virtually defunct theory of public ownership based on taxation and controlled and operated by politicians, the plan is proving satisfactory both in providing the highest type of service and in giving to the individual consumer an opportunity to become an owner of the securities which his patronage maintains.

It is not to board room financiers that I am addressing these remarks, because they are grounded in the fundamental principles of safe investment and have at their disposal abundance of accurate information on which to base their decisions. It is rather to those of our own electrical profession that I wish to pass the word, that they may pass it again to the hundreds of thousands of men who turn the switches in our great factories and to the millions of women who push the buttons in the flats and cottages when the lights go on, so that all these may understand the opportunity to take part in the great movement to electrify America and make production and prosperity continue even though the fuel supplies of the earth become exhausted. They are the same people who constituted the twenty-nine million buyers of Liberty bonds. If they were to become owners of the equity money in our electrical public utilities, the question of developing our resources to the utmost limit and by interconnection making each kilowatt work to its full capacity would be solved and the question of electrical financing would become automatic.

Co-operation for the Central Station and Isolated Plant

Interconnection Is Economically Sound and Is Shown to Hold Mutual Advantages Where Isolated Plants Can Be Justified

(By a Prominent Engineer and Central-Station Executive)

TOO MUCH intolerant prejudice and not enough good engineering judgment have fostered the appearance of irreconcilable conflict or antagonistic competition between central stations and isolated plants, when each really has functions to perform and there are unquestionably some situations in which an isolated steam electric plant can show advantages over the use of purchased electric power service. This is particularly true in cases where requirements for heating the premises may be satisfied by the use of exhaust steam. The point which has been most frequently ignored is that in nearly all cases where an isolated plant is economically justifiable important additional economies for that plant and for the central station can be obtained by interconnection and co-operation.

The installation of power-producing equipment in large office buildings, department stores and similar places was a general practice some years ago, but changes in price levels and other conditions have narrowed the field of the isolated building plant. From the viewpoint of fuel conservation alone there is some apparent saving in producing by-product energy from a heating plant when the heating requirements for exhaust steam balance the simultaneous requirements for electric power. However, such ideal correspondence between heating and power requirements seldom or never occurs, and even if it is approximated the value of the fuel saved is seldom sufficient to carry the additional operating expense and the investment charges for engines and generators.

Interchange of Energy Offers Economical Solution of Problem

The most economical solution of the problem can be effected in favorable situations through an interchange of energy with a central station. The isolated plant should be operated only as required by the demand for heat. The electrical energy made available as a by-product of the heating varies in quantity in quite a different way from the power required by the building in which the plant is installed, but with the scheme outlined the surplus or deficiency of that plant's electrical output can be delivered to or taken from the general distribution circuits of the central station. The considerable saving in fuel made possible by such interconnection may enable the small plant to sell energy at some profit to the distributing system and with advantage to the central station, which would supply all energy during the non-heating period each year. The isolated-plant fixed charges for the whole year must be earned during the heating season, but even so the gross operating costs can be lower for a plant designed for operation in connection with the central station than for a plant designed for isolated operation. If these practices were more generally adopted they would reduce the discreditable evidence of waste exhibited by the numerous "white feathers" of exhaust steam which crown so many skyscrapers.

The working out of the details of an agreement for interconnected operation is apt to be tedious and difficult unless both parties to the negotiation keep clearly in mind the simple purpose to utilize their respective facilities jointly to save fuel economically. The proportion of such saving to be received by the respective parties should not be difficult to negotiate. That the problem can be solved satisfactorily is indicated by experiences of several of the larger central stations in different sections of the country.

In at least one of our largest cities the local central station has supplied electric service to every new office building erected during the last five years. It can also be stated in general that no small isolated steam plants are being installed solely for producing power where central-station service is available and fewer power plants of any size are being installed in office buildings and similar places. When fuel became scarce and expensive isolated plants were shut down with alacrity and their load was transferred to the central stations, whose rates had not been correspondingly increased. Much coal has been saved during the last three years by this shifting of load, but it has not made it any easier for the central stations to finance plant additions and extensions.

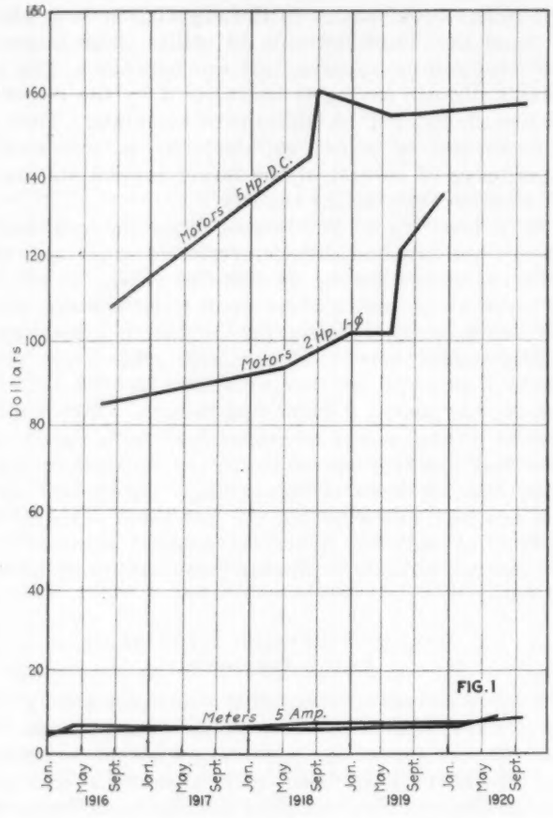
Ease of Financing a Factor in Plant Ownership

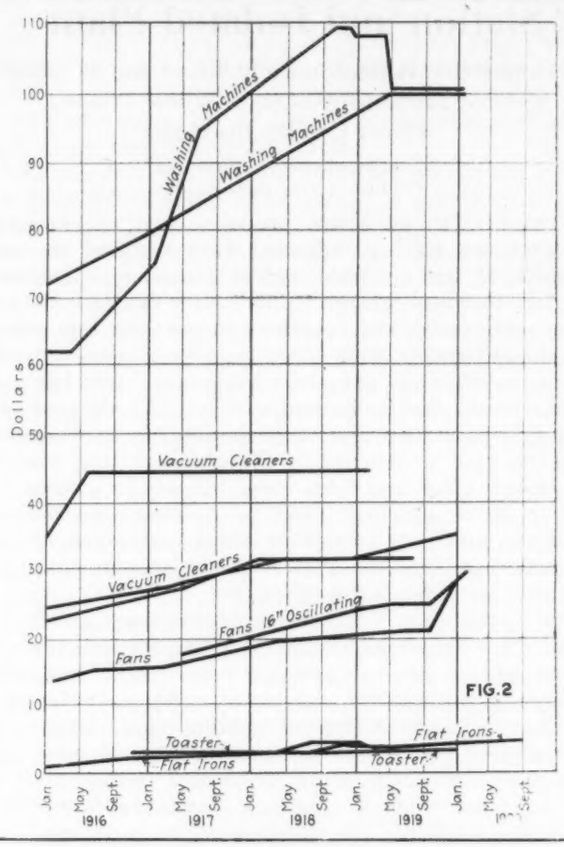
Some observers have expected a tendency among large industrial companies to discontinue central-station service. The reason for this expectation is that numbers of manufacturers have been very prosperous and could finance a power plant on more advantageous terms than could a central station at the present time. Such a course may be justified when the factory load warrants the use of generating equipment which approaches closely the fuel economy of the central station's plant, when the factory has an advantageous site, and when there is need for steam in the factory process or there is waste heat from the process. However, even under such favorable factory conditions an isolated plant can attain greater economies if operated in connection with the general system of the central station.

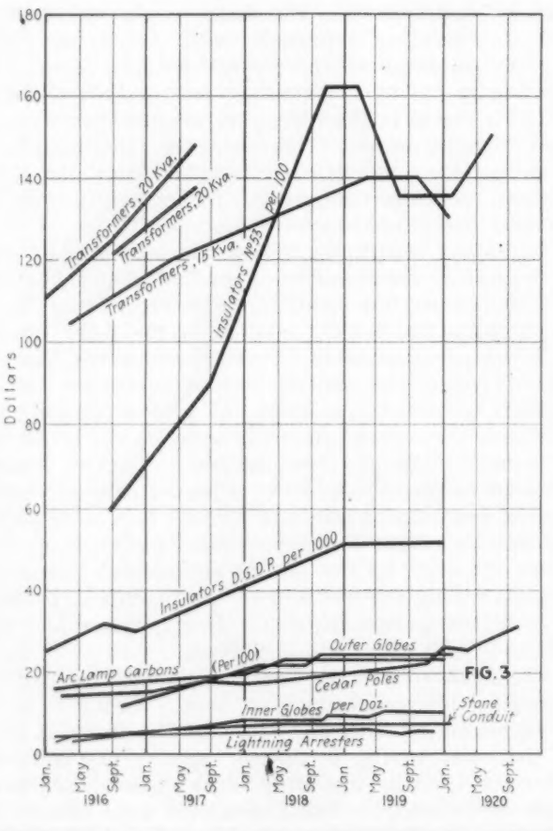
In several localities progress has been made toward co-ordinating the operation of the central-station system and the economical plants of large factories. The arrangements are usually similar to the more familiar interchange agreements between two central stations. In some cases the central station purchases a stated amount of power; in others the central station takes whatever the factory plant can spare to the extent that the central station then desires to receive energy. Further co-operation is to be expected between central-station and isolated plants as a result of a more general recognition of the interconnection benefits which were given emphasis by the several government boards and officials during the war and by the prominent examples in California, New England, Pennsylvania and elsewhere in this country and abroad.

The most noteworthy benefits obtained from utility-industrial interconnections are those relating to saving in aggregate rated capacity through the diversity factor of the loads, saving in reserve capacity of plants, and saving of fuel by operating large modern turbines at high load factors. These practices tend toward the greatest economy in the production of electrical energy, but they are still relatively wasteful in the utilization of the heat energy obtained from fuel.

Cost of Electrical Apparatus and Supplies to Large Central Stations


Dollars
Motors 5 Hp. D.C.
Motors 2 Hp. 1φ
Meters 5 Amp.
FIG. 1
Jan. May Sept. Jan. May Sept. Jan. May Sept. Jan. May Sept. Jan. May Sept.
1916 1917 1918 1919 1920





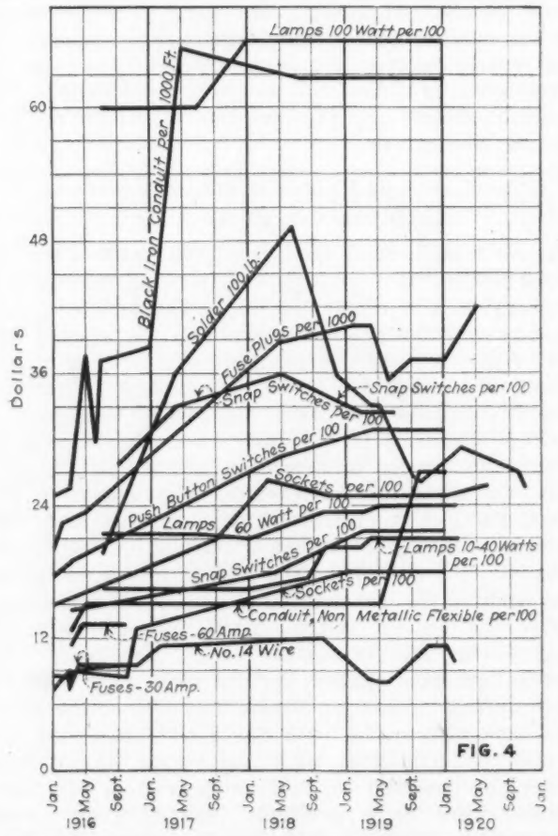
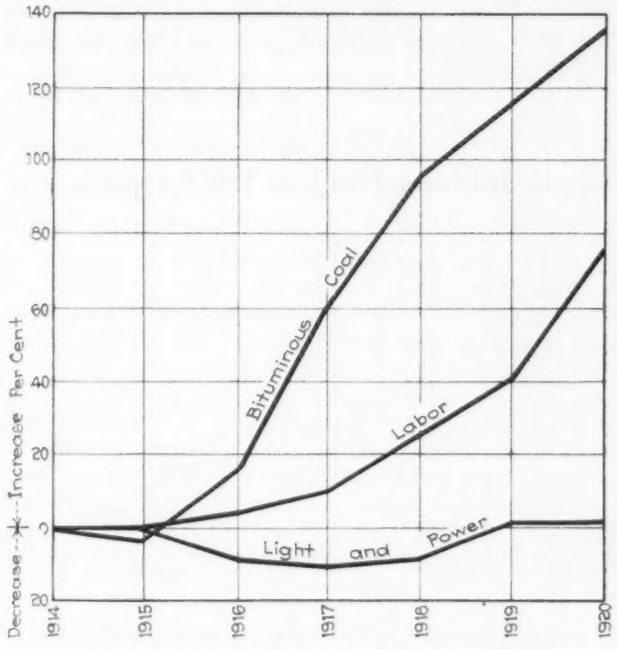

Dollars
Lamps 100 Watt per 100
Black Iron Conduit per 1000 Ft.
Solder 100 Lb.
Fuse Plugs per 1000
Snap Switches per 100
Snap Switches per 100
Push Button Switches per 100
Sockets per 100
Lamps 60 Watt per 100
Lamps 10-40 Watts per 100
Snap Switches per 100
Sockets per 100
Conduit, Non Metallic Flexible per 100
Fuses-60 Amp.
No. 14 Wire
Fuses-30 Amp.
FIG. 4
Jan. May Sept. Jan. May Sept. Jan. May Sept. Jan. May Sept. Jan. May Sept. Jan.
1916 1917 1918 1919 1920

Fig. 1—Motors and meters. Fig. 2—Household appliances. Fig. 3—Line material. Fig. 4—Interior wiring devices.

Insufficiency of Electric Rate Schedules

While Prices of All Material and Supplies Have Increased Greatly, Electricity Prices Remain Almost Constant

THE handicap under which almost all electric public utilities are operating is not generally appreciated. For some unknown reason people imagine that conditions which affect them adversely have no effect whatsoever on public utility corporations. Every man realizes to what extent the high cost of living has affected



TREND IN PRICE OF COAL, LABOR AND ELECTRICITY

him. Food has increased 150 per cent in the last five years, clothing 190 per cent, coal 135 per cent and other lines of material in about the same proportion.

If one stops to consider that coal is one of the chief items of expense in generating electricity, and that labor, which has increased in cost anywhere from 75 per cent to 100 per cent, is also essential, the reasonableness of increased rates of electric service will be apparent. Nevertheless, during the past five years the average rate for electrical energy has not increased perceptibly, but on the contrary has decreased in cost during a portion of that time. What is true of coal and labor is also true of equipment necessary to the generation and distribution of electricity, and, as though that burden were not enough, taxes which every central station must pay have increased 120 per cent.

Figs. 1, 2, 3 and 4 show the trend in prices to large electric central-station companies of motors and meters, household appliances, line material and interior-wiring devices. It must be remembered that while the curves showing the increases above in the cost of bituminous coal and labor are based on official government figures and represent therefore the average condition throughout the country much greater increases have taken place in isolated cases. One of the great handicaps to the more rapid extension of electric service has been the lack of funds for new developments and enlargements. These funds would have been forthcoming had the earnings of the respective utilities been ample to justify the loans, and the curves shown herewith indicate very plainly why earnings were not of a magnitude to demand the needed capital.

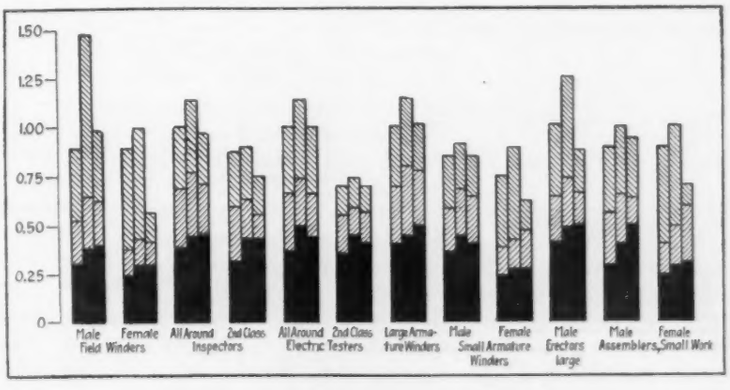
The exhibit indicates how great has been the burden thrust upon the electric public utilities and how unreasonable have been the protestations against the increases in rates. Rates have not advanced during the inflation period incident to the war and the period immediately following it, and there is imperative need of readjustment to meet the changed conditions.

The experience of the steam railroads would indicate that the country is more interested in service than in rates, and yet it is impossible to give good service without competent labor, adequate equipment and ample returns to pay for both. It is essential that the public understand this because once it is comprehended the chances are there will be a fair reception to increased rates when such are requested. The same reasoning ought to apply to the public service commissions. They may not always appreciate how almost impossible existing conditions are. Certainly the business of supplying electric light and power is a legitimate one, and it is unreasonable to expect all the burdens of increases to be borne by the utilities alone and not shared by their consumers as well.

For the public good, the rates permitted must be such as to keep the utilities in a going condition. The public has a right to expect, besides a dependable and sufficient service, a condition of stability that will not waver with every market fluctuation. If this cannot be assured on existing rate schedules, the sooner the latter are amended the better.

Manufacturers' Labor Cost

IN the electrical manufacturing field there have been no very great labor troubles during the past year. So far as can be learned no dissatisfaction is apparent with existing conditions and schedules. There have been no calls of any consequence for shorter weeks with increased wage, nor are any demands of that kind expected. Working hours, which range from forty-



WAGE SCALE OF ELECTRICAL WORKERS

eight to fifty-five hours a week, with an average of fifty hours a week, and a half day Saturday, have not been reduced.

The accompanying curves indicate the range in pay

per diem for both male and female employees engaged in electrical work.

Machine and tool work command the prevailing wage in all machine shops in the district and are little influenced by electrical manufacturers. There are wide variations in the wages paid depending on local conditions. Labor is usually cheaper in small towns than in the large cities and sometimes various degrees of skill command compensation according to the measure of efficiency shown.

The scales shown depict conditions in a representative group of electrical manufacturing companies. The entire wage range is indicated by that section of the diagram above the black portion, the top showing the highest wage reported, the bottom the lowest wage reported and the line between these two shows the average wage of all of the manufacturing companies which have reported.

Condition of Jobber's Business

With Heavy Stocks on Hand and Little to Be Received, Jobbers Will Buy Lightly for First Quarter of the Year

UP TO the fall months the electrical supply jobbing business was exceptionally good. Then the buying strike began to get under way, and naturally the jobbers were not long in feeling its effects. Still, it has been estimated by one who should be in the best position to know that the gross business in the jobbing trade for 1920 probably ran ahead of 1919 by 40 per cent. Inasmuch as 1919 business was stated by this same authority to have been in the neighborhood of $300,000,000, the 1920 business probably did not fall far short of $425,000,000.

At this writing, however, the interest does not lie in

Summary of Conditions in Electrical Supply Jobbing Field as 1921 Opens

District	Condition of Stocks, Days	Inventories: Compared with Jan. 1, 1920	Inventories: Compared with Sept. 1, 1920	First Quar. Buying a—Hand to Mouth b—Light c—Heavy	Quantity Material Still to Come	Shall Price Be Cut to Stimulate Buying?	Outlook
New England—six replies	1—60 1—90 1—120 1—180	1—10%+ 1—20%+ 1—30%+ 1—33%+ 1—50%+	1—10%+ 3—Less 1—40%—	6—a	3—none 3—little	1—yes 1—no 1—mnfrs. 1—market	1—fair 1—not bright 1—uncertain 2—poor first quarter, good thereafter
Middle Atlantic—twenty-one replies	1—30 1—45 5—60 1—74 5—90 1—60-90 1—100 1—180	1—15%+ 4—25%+ 1—28%+ 1—37½%+ 1—43%+ 2—50%+ 1—100%+ 1—higher 5—same 1—20%— 1—25%— 1—30%—	1—25%+ 6—same 3—10%— 1—20%—	8—a 11—b 1—c	12—none 3—little 6—large on some items	6—yes 9—no 2—mnfrs. 2—market	4—fair 5—good 2—bright 5—poor first quarter, good thereafter 1—inactive up to fall
South Atlantic—four replies	1—75 1—90	2—25%+ 1—40%+ 1—99%+	1—5%+ 1—27%+	2—a 2—b	2—none 2—little	3—no	2—good 1—poor first half, good second half
East North Central—fifteen replies	2—40 2—45 5—60 1—65 1—90 1—90-120 1—150	3—20%+ 2—25%+ 2—30%+ 1—39%+ 1—50%+ 1—100%+ 4—same 1—20%—	1—11%+ 1—15%+ 2—20%+ 1—same 1—less 1—15%— 1—20— 1—66%—	7—a 7—b	6—none 7—little 2—large some items	4—yes 10—no 1—mnfrs.	3—fair 3—good 1—encouraging 4—poor first quarter, good thereafter 4—poor first half, good second half
East South Central—seven replies	1—60 1—90 1—90-120	1—60%+ 3—100%+ 1—favorable 1—lower	1—30%+	4—a 3—b	5—none 2—little	3—yes 4—no	1—good 1—uncertain 1—discouraging 3—poor first half, good second half
West North Central—nine replies	1—45 2—60 1—75 1—75-90 2—60-90 2—90	1—15%+ 1—20%+ 1—30%+ 1—70%+ 1—same 1—less	1—15%+ 3—same 1—50%—	5—a 4—b	4—none 2—little 3—large some items	4—yes 2—no 1—mnfrs.	3—good 2—poor first half, good second half 4—poor first quarter, good thereafter
West south central—ten replies	1—75 1—90 1—120 1—180	1—20%+ 1—25%+ 1—30%+ 1—33⅓%+ 1—87%+ 1—100%+ 3—higher	1—10%+ 1—25%+ 1—30%+ 1—45%+ 1—same	5—a 5—b	7—none 3—little	5—yes 4—no	1—excellent 3—fair 1—poor 2—good 1—optimistic 1—better than 1920
Mountain—four replies	1—90 1—125 1—120-150	1—21%+ 1—32%+ 1—50%+ 1—same	2—same 1—5%— 1—18%—	2—a 1—b	2—none 1—little 1—large some items	4—no	1—good 1—off 1—not encouraging
Pacific—six replies	2—60 1—75 2—90 1—120	1—20%+ 1—25%+ 1—33⅓%+ 1—81%+ 2—same	1—30%+ 1—9%—	2—a 4—b	4—none 2—large some items	2—yes 4—no	1—fair 2—good 1—no good 1—better than 1920 1—poor first quarter, good thereafter

the past but in the present and future. How does the jobber enter the new year? Are his stocks long or short, and how much? Will he buy from hand to mouth or lightly or heavily? Will he buy heavily for first quarter in any particular lines? Has he much material on order with manufacturers? Will he cut prices to stimulate business? What is the outlook in his territory for 1921?

ANALYSIS OF 82 ANSWERS

These questions the ELECTRICAL WORLD has asked the electrical supply jobbers of the country, and at this writing it has received answers from eighty-two of them. These answers, which are analyzed in the accompanying table according to sections of the country, afford an excellent cross-section of the condition of the electrical industry and are the best indication anywhere available of what may reasonably be expected in and from this branch of it.

Except here and there, no low stocks are reported. Only occasionally does the survey reveal less than sixty-day stocks. For the most part stocks are over sixty days, and a great many are ninety days or more. While many said that their stocks were average or normal or not large, still it is apparent that stocks rather generally are much larger than the current market warrants. A number of jobbers reported that the overstocks were for the most part in a few lines, and these as a rule were household socket devices, flexible conduit, both metallic and non-metallic, flexible armored conductor, wire, both rubber-covered and weatherproof, and schedule material.

There were occasional evidences of unbalanced stocks, and in these cases it was the rule to find short stocks of porcelain, especially tubes, rigid conduit, steel boxes and motors. A half dozen or more jobbers, strangely enough, reported a shortage of rubber-covered wire.

INVENTORIES LARGER

Inventories grew greatly during the year owing to advances in price on the one hand and to larger receipts on the other. November and December inventories were for the most part from 20 to 50 per cent higher than those at the beginning of 1920. In some cases they were even 100 per cent and 150 per cent greater. Some, however, did not show any change, and in a few instances they were even lower. While a number, owing to decreased buying on the part of customers and to heavier receipts, have accumulated larger stocks, still a good many jobbers have been able materially to reduce stocks since September. On the whole, therefore, jobbers on Jan. 1, 1921, are in a much healthier state than they were at the end of the third quarter of 1920.

With the exception of one house, which will buy heavily for first quarter, the electrical jobbers for the next three months will buy either from hand to mouth or lightly. Some indicated that normal stocks will be maintained.

Almost without exception the canvass shows that the electrical jobber will not buy heavily on any single item for the first quarter.

For the most part, the jobbers have received all the material they had on order with the manufacturers. A number of houses have still a few minor unfilled orders on manufacturers' books. There are some cases, however, where large orders are still unfilled, but these almost without exception are for not more than two or three lines, such as rigid conduit, motors, porcelain and schedule material in which stocks have not yet been built up. A large number of the reporting houses stated that although they had large commitments a while back they had canceled these orders.

SHALL PRICES BE CUT?

On the question of price reduction the replies were varied. It was known that not a few jobbers had made recessions to stimulate buying in order to reduce long stocks, and for that reason a consensus of opinion was asked. Some evaded this question, but of those who made reply 52 per cent were against reducing prices to stimulate a market. Where a reason was given it was, for the most part, that a falling market discourages buying. On the other hand, 35 per cent were in favor of reducing prices, some without reservations, others on lines that had to be moved because of overstocks, and still others with the proviso that it should be done gradually. A little more than 8 per cent were of the opinion that reduction should originate with the manufacturers. The remainder simply said that they would follow the market down.

OUTLOOK

The greatest variation in the answers came in reply to the question "What is the outlook for 1921 in your territory?" Some were very optimistic and others were equally pessimistic. Generally, however, the replies held to the middle ground. The first quarter is not for the most part expected to be anything but dull. After that conditions are expected to grow better. Some put the Presidential inauguration as the turning point. It was generally agreed, however, that the second half of the year will be pretty good and the last quarter excellent.

The feeling arrived at from reading the replies is that the gross volume of business done in 1921 will not be so large as that in 1920. How much smaller it will be it is not possible to determine from the replies. Still, from the apparent probability of lower prices and the expressed certainty of a smaller volume of goods moved, it does not seem unreasonable to predict that the gross business of 1921 will be at least 25 per cent less than that for 1920.

Causes and Possible Remedies of Cancellation Evil

AN EXHAUSTIVE study of the practice of cancellation of orders and repudiation of contracts in almost every division of business has been made by the fabricated production department of the Chamber of Commerce of the United States. As a result of this study it groups opinions as to possible causes and possible remedies under these three heads:

"First—That the practice is the result of war-time irregularities and will pass as we return to a normal basis.

"Second—That we are now reaping the results of the loose business practices inaugurated before the war, when many lines were in a state of overproduction and the measures taken to unload this surplus were demoralizing. Those entertaining this belief feel that the remedy is in a general reformation of our system of order taking, making each order a contract enforceable by law.

"Third—That we have been drifting away from the fundamentals of sound business and the 'Golden Rule' and that we must return to a stronger belief in the rights of others and a higher regard for our own integrity if the change is to be permanent."

Interconnection Benefits Even the Small Plants

Tidewater Steam Plant and Nearby Water-Power and Steam Installation Handled Effectively by Tie Line Under Various Load Conditions

AN INTERESTING example of the benefits of interconnection is afforded by a 4.5-mile (7.2-km.), 13,200-volt single-circuit tie line between generating stations of the Newburyport (Mass.) Gas & Electric Light Company and the Amesbury Electric Light Company. The former company operates an 8,325-kva. steam plant on tidewater near the mouth of the Merrimac River, and the latter receives energy from a group of small hydro-electric stations with steam auxiliary equipment aggregating about 3,000 kva. The two companies are independent, and each serves important industrial power and the usual lighting business to be found in New England manufacturing centers.

The chief advantage of this interconnection lies in the opportunity it offers for the supply of energy to the Amesbury district from the larger tidewater stations, especially during periods of low water at the hydro-electric plants. The hydro-electric stations are in the valley of the Powow River, which rises in Kingston, N. H., and flows by a crooked course southeasterly until it finally joins the Merrimac River near Newburyport.

The tie line has a capacity of about 1,800 kw. It consists of a three-phase circuit of No. 2 copper between the principal hydro-electric station in Amesbury and a terminal tower on the north bank of the Merrimac River, opposite the Newburyport station. Choke coils, taps to disconnecting switches and electrolytic lightning arresters and disconnecting switches by which the line can be opened at the terminal tower are provided. The connection with the Newburyport plant is completed by a three-conductor, 13,200-volt armored submarine cable 1,655 ft. (506 m.) long, terminating in a pothead mounted on an outdoor steel frame inclosing three 625-kw. Maloney transformers installed just outside the station. At this pothead disconnecting knife switches are provided so that the submarine cable section of the line can be opened at this end also. A short cable run from the transformer secondaries to the 2,300-volt bus of the station completes the tie.

The greater part of the time energy is supplied over this line from Newburyport, but at times of very light load in Newburyport, as on Sundays, if water is plentiful in the Powow River, the entire load of the tidewater station is frequently carried by Amesbury. This obviates running a 625-kva. steam-turbine unit. The larger plant, however, is the mainstay of the two systems as regards steam reserve and is needed to handle the main load of Newburyport, including the Ipswich Mills (reached by a 22,000-volt two-circuit line) under week-day conditions.

In the fiscal year 1919 the Newburyport company sold to the Amesbury company 2,397,000 kw.-hr. at a unit price of 1.352 cents. The Amesbury company sold Newburyport 15,570 kw.-hr. at a unit price of 1.645 cents. The total output of the Newburyport station was 12,400,434 kw.-hr., and the average cost per kilowatt-hour produced at Newburyport was 1.26 cents. Coal cost $8.40 per ton at Newburyport, 14,975 tons being used.

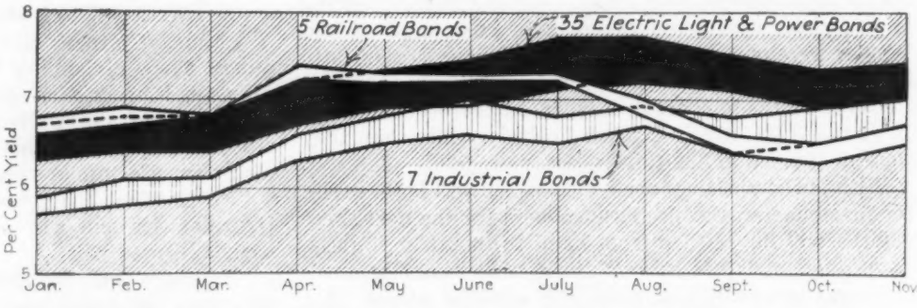
Amesbury's total energy delivery to the bus from the local plants was 496,916 kw.-hr. at a unit cost of 1.82 cents. The line losses in the case of energy delivered to the Amesbury company are borne by the latter, but even so these figures are an interesting example of the economy of centralized energy production in a steam-turbine plant with the units under one roof, as well as an indication of the difficulty of securing low unit costs of operation in a mixed system of scattered hydro-electric plants of small capacity. Each of these generating systems may be and is of use to the other, and the fact that the larger plant supplies the greater portion of the energy utilized on the smaller system in no way invalidates the actual and potential benefits of the interconnection from the viewpoint of the bigger installation. Light-load periods in steam stations are most desirable times to use surplus energy, and the harmonious interoperation insures fuel and water mutual conservation.

Trend of Electric Light and Power Bond Yields

DURING the twelve months just past money cost more than in any previous year in the history of the electric light and power business. In the neighborhood of $400,000,000 of new capital was placed on the market by electric light and power companies at a price which would yield the investor on an average 7.98 per cent.

Older issues did not yield such a high average, but the yield was high enough to attract many new investors in this class of securities. The trend of this market is shown fully in the accompanying diagram by the heavy black curve. Compared with this is the trend of average yield of railroad bonds and industrial bonds.

It is interesting to note that the yield on the utility bonds is only slightly more than from the industrials and about the same as from the railroads. It must be pointed out, however, that while all kinds of electric light and power issues (all first mortgage) are included, the industrials and railroads are picked issues. The former include one of each of a number of fundamental commodities in which the strongest company was picked out. In the railroads geographical distribution of operation was used, with the most representative road in each case.



ELECTRIC LIGHT AND POWER BOND YIELDS COMPARED WITH INDUSTRIALS AND RAILROADS—WIDTH OF CURVES SHOWS RANGE BETWEEN BID AND ASKED PRICES

Engineering Developments of 1920-21

IN REVIEWING THE DEVELOPMENTS and tendencies that prevailed last year in electrical engineering, those that are most important have been segregated and arbitrarily classified under the following headings: Generation and Protection, Transmission and Distribution, Science and Research, Lighting and Industrial.

Recent Tendencies in Water-Power Practice

Reaction Wheels Built in Sizes Up to 55,000 Hp. and Others with 800-Ft. Head—New Draft Tubes of High Efficiency—Outdoor Plants

BY JOHN F. VAUGHAN
Consulting Engineer, Boston

PROGRESS in water-power practice during the past year has been in detail of construction and refinement of operation rather than in radical change of plant design or type of equipment. The controlling factors have been high price of money and high cost of labor and material. While these factors react against both steam and water power the increase in cost of steam power due to high price of fuel has been offset to a large degree by the relatively greater first cost and fixed charges of water power. The direct effect has been the stimulation of interconnection, the simplification of plant layout, increase in rating and decrease in number of units, the placing of more apparatus out of doors and the more economical use of building space. Other tendencies are better control of storage and pond level in moderate and low-head plants, reduction of back water hp., depending largely upon transportation facilities. Impulse wheels have reached a size of 30,000 hp. under a 1,000-ft. (300-m.) head in the units being built for the new Caribou development of the Great Western Power Company. In the design of low-head, high-speed runners of the unshrouded or propeller type (such as the Nagler in this country), specific speeds of 175 have been reached without serious sacrifice of efficiency and runners have shown an unusual range of head-speed characteristics. Owing to the high cost of raw material for medium-head work, foreign manufacturers are using higher specific speeds than is considered good practice in this country, sacrificing efficiency to some extent, however, in doing so.

The reaction wheel has reached a new limit of head, 800 ft. (240 m.), in two 22,500-hp. units now being built for the Kern River No. 3 plant of the Southern California Edison Company. Owing to the excessive velocity in the draft tube and high generator speeds, it is likely that even in large units this head encroaches far into the territory of the impulse wheel. Low limit of head has been extended by the further use of the unshrouded or radial-flow propeller type of runner.

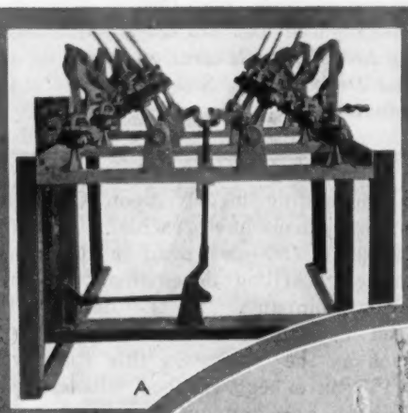
Efficiencies of 93 per cent and better have been established in medium and large-size vertical spiral-case units under favorable conditions, and better fractional-load efficiencies than those of the past have been maintained. One manufacturer has approached this maximum efficiency in the low-head, high-specific-speed type, and others are progressing along similar lines.

The last word in draft-tube design appears in the White hydraucone and the Moody spiral-case types recently tested on the new 40,000-hp. wheels of the Niagara Falls Power Company, which have given virtually the same results in efficiency. It is interesting to note, however, that a modification of the more common quarter-turn type of draft tube is to be installed with

HYDRO-ELECTRIC PLANTS EMBODYING MOST RECENT DEVELOPMENTS

Company	Name of Development	No. of Units	Size of Units (Hp.)	Type of Units	Head (Ft.)	Features of the Plant
Hydro-Electric Power Commission of Ontario, Toronto	Queenston	5	50,000	Vertical spiral-case	305	Largest reaction-type units
Great Western Power Co., San Francisco, Cal.	Caribou	..	30,000	Impulse	1,008	Largest size for such a head
Southern California Edison Co., Los Angeles, Cal.	Kern River No. 3	2	22,500	Spiral-case	800	Highest head for reaction wheel
United States Government, Ordnance Dept.	Muscle Shoals	4	30,000	Concrete spiral case	95	Highest head for concrete spiral case. Outdoor plant considered
Los Angeles (Cal.) Bureau of Power and Light	San Francisquito	2	22,000	Vertical spiral-case	515	.....
San Joaquin Light & Power Corp., Fresno, Cal.	King's River	..	300,000 total	Impulse	2,500	.....
Pacific Gas & Electric Co., San Francisco	Hat Creek (Nos. 1 and 3)	2	15,000	.....	200	.....
Great Lakes Power Co., Ltd.	Sault Ste. Marie, Ontario	..	.....	.....	18	.....
Central Maine Power Co., Augusta, Me.	Skowhegan	5	22,500 total	Concrete spiral-case	32	Collapsible crest dam.
Henry Ford's plant	Troy, N. Y.	..	.....	.....	...	Extreme use of large units under low head.
Consumers' Power Co., Jackson, Mich.	Grand Rapids	2	200	.....	....	Automatic and semi-automatic plants
	Battle Creek	1	150	.....	....	
Tallassee Power Co., Baden, N. C.	Baden, N. C.	..	.....	.....	....	
Iowa Railway & Light Co.	Cedar Rapids	3	500	.....	....	

Some Important Developments in Electrical Apparatus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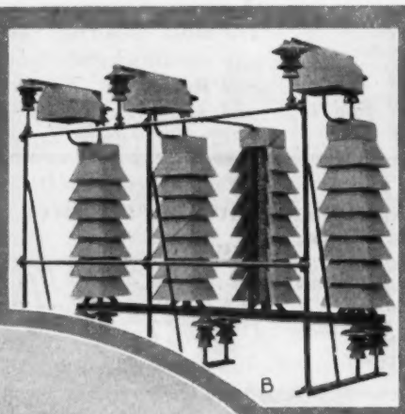
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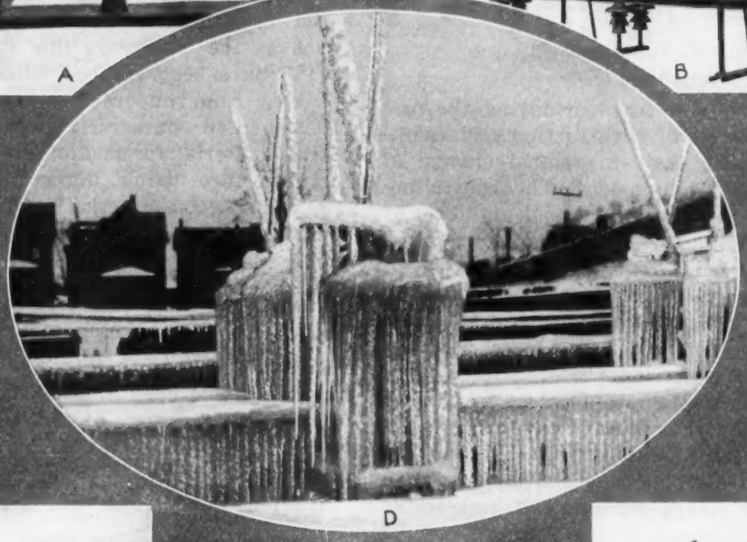
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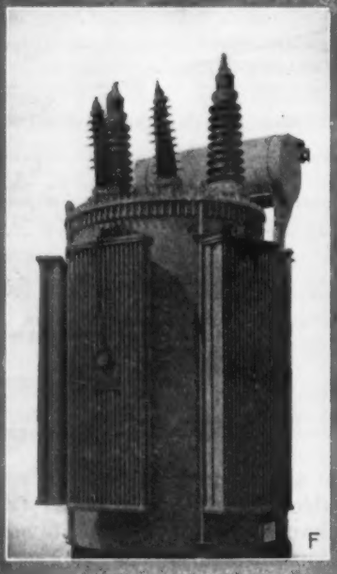
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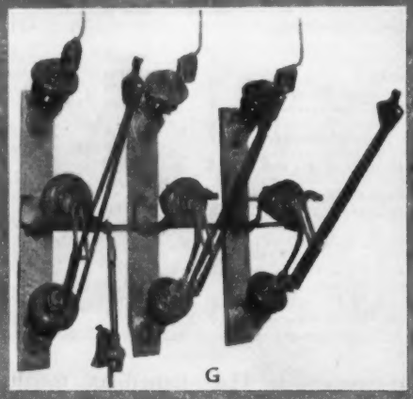
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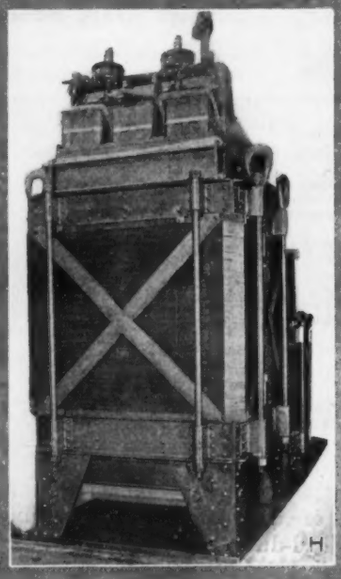
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A—New type of air-break switch with vertical break. B—Oxide-film lightning arrester for outdoor service at 73,000 volts. Ground-stack shields removed for inspection. This arrester contains no liquid. C—Outdoor 250,000-volt bushing for Southern California Edison Company. D—Burke air-break motor-actuated switch operating at 80,000 volts despite ice coating. E—Bennett surge arrester for wide range of voltage. F—A 3,000-kva., 110,000-volt transformer with oil conservator and radiators. G—New air-break switch with vertical blades. H—The largest single-phase transformer that has been built in this country—23,600 kva., 132,000 volts, weight 63 tons.

two machines now being constructed for Queenston, and equally good results are anticipated for them by the manufacturer.

More attention is being paid to the recovery of head lost from high backwater, as by the Herschell and Replogle fall increasers, employing high-velocity flow from the dam into the horizontal discharge leg of the draft tube, and by the Tefft method, which slips a fast-moving sheet of water under the discharge within the draft tube. Another method offered introduces an annular jet from the flume itself down into the throat of the draft tube, and still another utilizes the negative head of the standing wave below the dam by discharging the draft tube into the high-velocity water as it leaves the toe of the dam back of standing wave.

The siphon type of dam is receiving more attention, particularly in locations of limited dam-spillway length, one being under construction on the Pacific Coast, for instance, for use under a 190-ft. (57-m.) head.

The use of the Johnson type of hydraulically balanced needle valve for large penstocks is increasing, and other types of internal hydraulically operated valves are under development.

Differential surge tanks are becoming more generally used, as well as other means of penstock control such as the use of a diaphragm in the surge tank above the penstock connections and, in long pipe lines, the use of the governor-actuating synchronous relief valve.

Automatic and semi-automatic plants are receiving much study and new plants are going in, such as that of the Cazenovia Electric Company at Cazenovia, N. Y.

The ice problem is receiving unusual attention, particularly in the new developments on the Niagara River. The Hydro-Electric Power Commission of Ontario is experimenting on intakes of the Johnson type of slotted tubes laid in the bed of the river and the Groat plan of submerged weirs placed so as to divert surface currents away from, and deep water toward the intake.

Troubles with Large Turbines Are Being Overcome

More Care in Starting and Stopping Units Reduces Temperature Stresses—Changes in Design Have Also Helped—Fluttering of Bucket Wheels Stopped

BY W. L. ABBOTT

Chief Operating Engineer Commonwealth Edison Company, Chicago, Ill.

IN GENERAL there have been no marked developments in turbine design during the past year, the principal improvements having been changes in details of design and material to overcome the problems that have been encountered in large units,* namely, higher speeds and greater stresses. Since the tendency has been to push up the linear and the angular velocities of the revolving parts, it has required the combined knowledge and skill of the scientist and of the engineer to interpret and to protect against the destructive phenomena which have been manifested. Another subject which has attracted considerable attention has been running clearances, since turbine parts may be subjected to variations in temperature of as much as 500 deg. Fahr. (260 deg. C.).

*The General Electric Company has produced single-shaft units of 45,000 kw. rating, and the Westinghouse Electric & Manufacturing Company has built multiple-shaft turbines up to 60,000 kw capacity.

Of the several difficulties with which the turbine manufacturers and the turbine operators have to contend, that due to unequal expansion and contraction of casing, cylinders, diaphragms, shafts and blade drums under the widely varying temperatures to which they are subjected is the most prevalent, particularly at times when machines are being started up and when they are being shut down. The designer and the machinist measure the running fits and clearances in thousandths of an inch, only to find, after the machine has heated up, that some parts have expanded 0.25 in. (6 mm.) and other related parts have expanded much less. So serious is this matter of unequal expansions that the principal turbine-manufacturing companies have issued explicit instructions to guide turbine operators in starting their machines.

OVERCOMING TROUBLES DUE TO UNEQUAL EXPANSION AND CONTRACTION

When steam for warming up is admitted to horizontal turbines of the Parsons type the hottest of the steam rises to the top side of the cylinder, while the air and cooler steam settle to the bottom. The resulting unequal expansion of cylinder and blade drum causes both to arch upward slightly, but when the shaft is turned through 180 deg. end rubbing of both fixed and revolving blades is liable to result. With the Curtis type of turbine there is not this same trouble with end rubbing of blades, but there has been serious trouble due to unequal expansions. In this machine the bucket wheels are shrunk onto the shaft and keyed in place. The hubs of the disks and the diaphragm packing rings between them entirely cover that portion of the shaft in the zone of the hot steam. Therefore, when steam is admitted into the wheel space on starting up a cold turbine, the steam comes in contact with the wheel hubs and expands them, while the shaft, owing to its greater mass and because it is generally protected from direct contact with the steam, heats up more slowly. The hub of the bucket wheel, therefore, becomes loose on the shaft temporarily, and when the machine is brought up to speed the disk is liable to "wabble" until the hub and the shaft attain a common temperature. When the wheel wabbles it wears the bore in the hub larger and it wears its seat on the shaft smaller. When the machine is shut down the wheel hub cools more quickly than the shaft and thereby becomes decidedly stretched. After a few repetitions of this process the wheel is never tight on the shaft.

Manufacturers of reaction-type turbines have overcome the foregoing difficulty in different ways—some by more end clearance of the blading, others with blades having thin ends which will wear off quickly in case they rub and with a close-running, feather-edged shroud to intercept the spill around the end of the blading. The latter is designed to wear off quickly with little resultant heating in case of rubbing.

One large manufacturer overcame his trouble with wabbling wheels by using a pinned bushing in the hub of the wheel. This bushing will always approximate the same temperature as the shaft, leaving the hub free to heat up quickly and expand as it may. The bushing, however, while tight on the shaft, is secured to the hub by a number of radial pins, so that as the hub expands and contracts it will always be concentric with the shaft and the bushing, while the pins will keep it from wabbling.

Cast iron is being largely replaced by steel in dia-

phragms and casings, because with the high temperature of superheated steam cast iron is distorted more than steel, not only temporarily but permanently. The heating and cooling cause cast iron to swell permanently, or "grow," as it is sometimes called, thereby becoming porous and much weakened.

There have been a number of mysterious failures of bucket wheels from which segments broke off and were thrown out while the wheels were in operation. Some failures of this kind were traced to fractures starting from the sharp corners of equalizing holes near the rims of the disks of blade wheels and were due to metal fatigue. In working metal nearly up to its elastic limit there are apt to be some small corners or angles where a small particle of metal is more highly stressed than the general mass of the piece, and in such locations stresses may overrun the elastic limit. In time steel in such places becomes fatigued and microscopic cracks develop, which are slowly propagated to an extent which ultimately leads to complete rupture. Such fractures, starting in hair cracks at some sharp corner, may require weeks or months in developing to an extent which finally brings about a sudden ultimate rupture. Correction has been made by a new design of disk in which the web of the wheel is slightly thickened. Equalizing holes are placed nearer the hub than in the old wheels, and the corners of the holes are rounded off to eliminate sharp corners from which cracks start.

POLARIZED LIGHT USED IN STUDIES TO DETECT STRAINS IN METALS

It has been found to be virtually impossible to calculate the amount to which metal in the various parts of a disk is stressed while in revolution. However, a novel method for the study of these stresses has been devised by one of the large manufacturing companies. A celluloid disk is employed with buckets attached, all similar in proportion to the steel disk whose strains it is desired to investigate. The celluloid disk being transparent, light will shine through it, and when revolved at high speed the fiber in different parts of the disk will elongate in proportion to the stress to which that portion is subjected. These differences of elongation of the fiber in different zones of the wheel will be clearly shown by the differences in their ability to polarize refracted light.

With the various expansions, contractions and distortions due to heating and cooling, it was to be expected that there would be occasional instances where the bucket wheel, with its narrow clearance, would rub against the diaphragm. More clearance has been provided, but still such rubbing has persisted, and, strangely enough, wheels have been found *rubbed on both sides*, although they were centrally placed between diaphragms with an abundance of clearance, while other wheels on the same shaft would not rub at all.

In addition to the phenomenon of double rubbing, some of these wheels have been found to have radial cracks, and even wheels of the new design with thickened web have given trouble. Here indeed was a problem for the investigators of the research laboratory, who have found the cause of the trouble and at the same time explained a curious phenomenon—so common that it had never been given a thought. The statement of this phenomenon is embodied in the answer to such a question as the following: "Why does a flag flutter when borne rapidly through still air?" The answer gives a clue to why heavy plates of forged steel will also flutter if driven fast enough in a dense enough medium. These violent and continued wavings of the disk readily account for the radial cracks which have been found. The trouble has all been eliminated by simply stiffening the rims of the wheels.

REMOVING CONDENSED STEAM

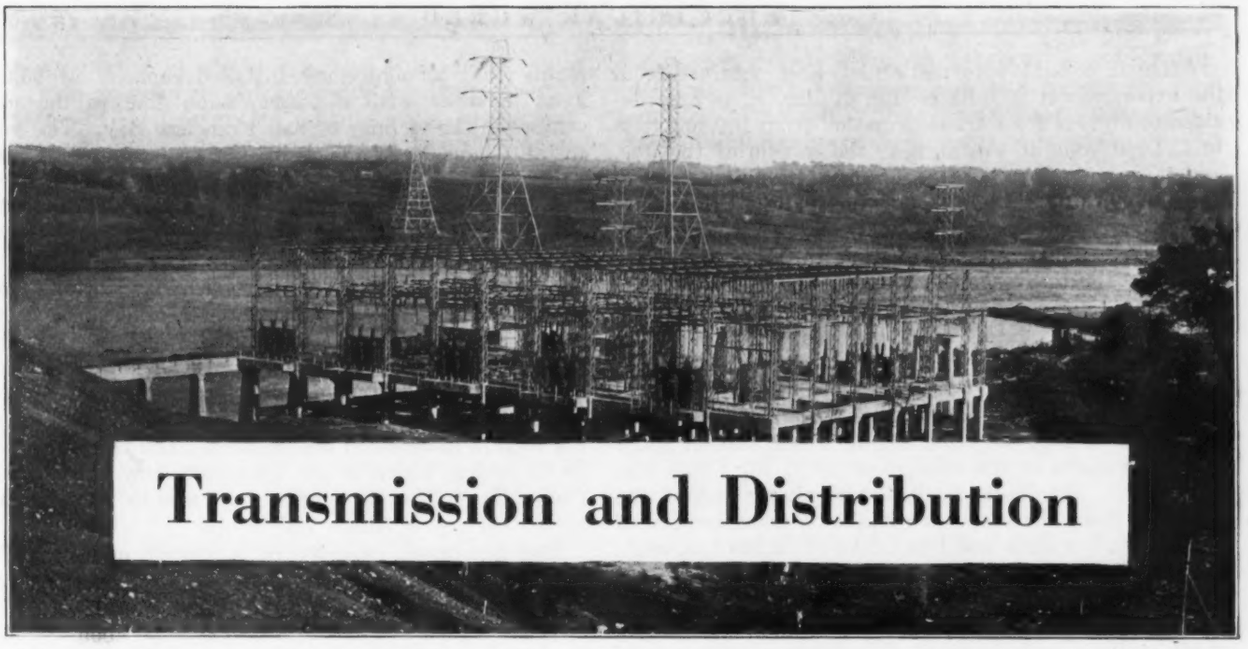
Superheated steam on its way through the turbine blading loses its superheat when about one-third of the way through, and from there on condensation takes place at an increasing rate. The point at which this condensation begins can be easily determined by an inspection of the blading, since those blades that are subjected to moisture are eroded, while those that run in the dry steam retain their original polish. The erosion has been such a serious factor in the last stages that it has been found necessary to drain the water from each stage independently—not into the next lower stage, but into the condenser. Drainage pipes have been installed for this purpose and designed so as not to leave a free opening for the escape of steam.

Great Hydro-Electric Development Planned in Germany

DISCUSSION is rife in Germany of a plan to construct a ship canal from Aschaffenburg on the Main to Nürnberg and to straighten the bed of the Danube River from Keilheim down to Passau at the German border. This scheme is an extension of a former plan to canalize the Main—the so-called Würzburg scheme. Development of many large hydro-electric plants forms part of the plan, which will provide a continuous ship canal from the Rhine to the Main and from the Main to the Danube. The importance of the proposed development to Bavaria, which has thirty-seven electric stations on the Danube, will be apparent.

It is proposed to divide the hydro-electric stations into two main groups—first, the group between Aschaffenberg and Würzburg, with thirty-four stations; second, the Danube group. Thirty of the first group of stations would be entirely dependent on the Main and would therefore supply a variable power in accordance with the height of water in the river. It is thought that ice would interfere with their operation in the winter to an average extent of ten days in the year. To overcome this steam reserve plants would be provided. Interconnection with other systems would take care of the variation in flow. The remaining four stations of the first group would have constant water levels which would render them independent, and their supply could be easily absorbed by the industrial districts of Würzburg, Bamberg and Nürnberg.

The total net output of the stations of the first group, after deduction of all losses in transformation and long-distance transmission, is put at 630,850,000 kw.-hr. a year, of which 291,400,000 kw.-hr. would be constant and the remainder variable supply. On the Danube only three large stations would need to be built—at Poikam, Regensburg and Steinbach in Kachlett. The first two would supply 53,910,000 kw.-hr. and the last-named 232,000,000 kw.-hr., or enough to take care of peak loads. The total possible supply of electricity to be developed by the project would thus reach 919,750,000 kw.-hr. a year, of which 291,450,000 kw.-hr. would be constant.



Transmission and Distribution

Transmission at 220,000 Volts in California

Plans of the Southern California Edison Company and Pacific Gas & Electric Company to Operate Long Lines at 220,000 Volts—Analysis of Engineering Considerations.

By H. A. Barre* and J. P. Jollyman†

THE commercial transmission of power at 220,000 volts, while not an accomplished fact, is assured by the advances which have been made during the year 1920. Scarcely more than a year ago, when the paper on the California 220,000-volt bus was presented to the Pacific Coast convention of the American Institute of Electrical Engineers at Los Angeles by Messrs. Sorensen, Cox and Armstrong, the subject did not receive serious consideration from many of the delegates present. Today plans are well under way for the construction of the two major portions of this bus, and the connection between them has actually been made by large-capacity ties at a lower voltage.

The two companies which have made the decision to resort to 220,000-volt transmission have been forced to it by purely economic considerations. In the case of the Southern California Edison Company the present two Big Creek lines will be loaded to their full capacity of 120,000 kw. at 150,000 volts in one or two years. It will then be necessary to provide additional transmission-line capacity before more generator units can be put into service at the Big Creek stations.

The transmission capacity can be doubled by the construction of two new 150,000-volt lines or by increasing the voltage of the present lines to 220,000. The first scheme will cost between $12,000,000 and $15,000,000, and the second will cost between $2,000,000 and $3,000,000, including the necessary changes in station equipment, which is a saving of approximately $10,000,000. Either of these schemes will provide for the transmission of 240,000 kw. After the development has reached this magnitude there will be approximately 500,000 kw. remaining for development, which will require seven additional 150,000-volt lines or three or four 220,000-volt lines. Assuming that a single line, whether for 150,000 volts or 220,000 volts, will cost $7,500,000, the ultimate saving on the Big Creek project effected by the adoption of 220,000-volt transmission will be roughly $35,000,000.

*Executive engineer Southern California Edison Company.
†Chief of hydro-electric and transmission engineering Pacific Gas & Electric Company.

Preparations by Southern California Edison Company for 220,000-Volt Transmission

The first steps in preparation for the adoption of 220,000-volt transmission have been taken: The equipment for the first unit at Big Creek power house No. 8 has been ordered with characteristics suitable for this transmission voltage. The transformers may be operated either at 150,000 volts or at 220,000 volts, and the generator will be suitable to control the voltage on one 220,000-volt line provided that a 30,000-kva. condenser is connected to the receiving end of the line. Because of the amount of water which will be available for this first unit it was not deemed advisable to have the generator of sufficient size to control the voltage on one 240-mile (386-km.), 220,000-volt line with the line open at the receiving end.

Plans have been made for energizing a 30-mile (48-km.) section of one of the present Big Creek lines at 220,000 volts. This experimental section of lines will be energized at one end from a bank of 4,500-kva. transformers connected in delta on the low-tension side and in star on the high-tension side, which will give a possible variation of line voltage from 206,000 to 272,000. The line will be open at the other end, since no transformers are available to make the transformation between 150,000 volts and 220,000 volts. Various groupings of standard 10-in. cap-and-pin insulators will be tried on this line in an endeavor to determine the best form of insulation to apply to the whole line.

The work of Prof. Harris J. Ryan at Leland Stanford, Jr., University, and of others, on the voltage distribution and the flash-over characteristics of long strings of insulators has shown beyond a doubt that line insulation for voltages of this magnitude can be provided successfully by the use of the standard insulators of today. Of course, better insulators are being sought constantly by the insulator manufacturers and by the power companies.

After all possible information has been obtained from the experimental 30-mile section of line, it may be decided to provide for a transformation from 150,000 volts to 220,000 volts at Vestal, near the middle of the line, and to operate half the line to carry power at 220,000 volts. It is very probable, however, that there will not be sufficient time to do this before the load conditions will require 220,000-volt operation through the entire length of the line.

The problem of changing the present station equipment to accommodate 220,000-volt transmission is one which requires very careful study of many different possible schemes. The present 150,000-volt equipment at the power houses consists of two banks of transformers of 17,500 kva. per bank at Big Creek station No. 1 and three banks of the same capacity at Big Creek station No. 2. At Eagle Rock, the receiving end of the 240-mile lines, there are two banks of transformers of 34,500 kva. per bank and two banks of 13,500 kva. each. At mile 105, numbering from the power houses, there is the Vestal substation with one bank of 13,500 kva. capacity and one bank of 34,500 kva. capacity. At all of these stations each bank of transformers and each of the two lines are connected to the high-tension double bus through 150,000-volt oil switches. Some of the ways of providing for 220,000-volt transmission follow:

At the Power Houses:

1. Provide a bank of auto-transformers having a capacity equal to that of the present installation at each power house, which will transform from 150,000 volts to 220,000 volts.
2. Replace the present transformers with transformers of the same capacity to transform from 6,600 volts to 220,000 volts.
3. Replace the present transformers with one bank of transformers having a capacity equal to that of the present installation at each power house, which will transform from 6,600 volts to 220,000 volts.

At Vestal:

1. Replace the present 150,000-volt transformers with 220,000-volt transformers of the same capacity.
2. Provide a bank of auto-transformers having a capacity equal to that of the present 150,000-volt transformers, which will transform from 150,000 volts to 220,000 volts. These auto-transformers should have a secondary winding for delta connection and for operating a 15,000-volt, 15,000-kva. frequency changer.

At Eagle Rock it will be very difficult to change to 220,000 volts, both because of lack of sufficient clearances in the building and because of the necessity for keeping the station in operation. Then, too, the benefits to be obtained from the change are not so great as they appear at first glance, because the present installation at 150,000 volts will deliver about all the power that can be taken away from that location at 60,000 volts and 15,000 volts.

For these reasons there is a strong tendency toward the plan of leaving Eagle Rock as it is and installing another station at a convenient point about 20 miles (32 km.) up the line. This station should provide auto-transformation from 220,000 volts to 150,000 volts of sufficient capacity to carry Eagle Rock, 96,000 kva. It should also provide the necessary 220,000-volt to 60,000-volt transformation and the additional condenser capacity required. The only way to decide which of these schemes should be adopted is to make a careful estimate.

PLANS OF PACIFIC GAS & ELECTRIC COMPANY

Early in 1920 the Pacific Gas & Electric Company resumed work on its Pit River projects and determined upon the immediate construction of three hydro-electric plants with an aggregate installed capacity of 95,000 kva., together with a transmission line to the load centers in the vicinity of San Francisco Bay. The total installed capacity of the company's projects on Pit River will ultimately be about 450,000 kva. It is anticipated that the major portion of the power developed along the Pit River will have to be transmitted to the districts bordering on San Francisco Bay, the load centers of which are 200 miles to 260 miles (320 km. to 420 km.) distant from the plants now being installed. To transmit the energy obtainable over the distance involved with the highest efficiency and at the lowest cost required the use of the highest practicable voltage, and 220,000 volts was adopted after a careful study of all the factors involved in the problem. The frequency will be 60 cycles, which is the frequency now used by the Pacific Gas & Electric Company and also by its neighbors in central and northern California.

The maximum capacity of a circuit of any given frequency is limited by the impedance drop over the line. For 60 cycles the maximum capacity of a 110-kv. line is about 35,000 kw. and of a 220-kv. line about 140,000 kw. The total weight of copper and towers in the 220-kv. line is about twice the corresponding weights in the 110-kv. line, but the capacity is four times as great; hence the weight per kilowatt transmitted for the 220-kv. line is only one-half as great as for the 110-kv. line. The adoption of 220-kv. where the power and distance are large enough to justify it is clearly indicated by these considerations.

A thorough survey of the possible difficulties that might arise from operation at a higher voltage than now in commercial use has been made. Four major problems are involved—first, transformers for higher line voltage; second, circuit breakers for higher voltage and larger capacities; third, insulators for higher line voltage and heavier mechanical loadings; fourth, the successful operation of circuits having greater capacity and higher charging currents.

The company's favorable experience with solidly grounded neutral on its 60-kv. system for more than twenty years and on its 110-kv. system for seven years confirms the growing belief that this is the only practicable arrangement for extensive high-voltage networks. It was, therefore, determined to employ solidly grounded neutrals at the generating plants and at the substations of the 220-kv. system. The use of the solidly grounded neutral greatly simplified the transformer problems. The transformers will actually be wound for fewer volts than those now employed on the 165-kv. systems in delta connections, and the use of one permanently grounded terminal greatly simplifies the problems of internal insulation. The development of suitable bushings for the higher voltages has been accomplished, and this permits a solution of the circuit-breaker problem as well as insuring the success of the transformers.

The improvements in suspension insulator units that have been attained in the last few years, together with the work of Prof. Harris J. Ryan and others, previously mentioned, appears to have made possible a suitable insulator for 220-kv. operation. The classic work of Peek and others on corona phenomena has furnished the basis on which the diameter of the line conductor may be chosen so as to avoid excessive energy loss into the air.

The charging kva. of a 200-mile, 60-cycle, 220-kv.

circuit amounts to 42,250 kva., and this introduces an operating problem to which careful consideration must be given. Obviously such a circuit cannot be energized by a generator of a few thousand kva. The solution lies in selecting a generator of sufficient capacity to charge the line to full voltage at the receiving station without becoming self-exciting. To control the voltage at the receiving end and permit the delivery of the maximum load over the line synchronous condensers must be used at the receiving stations. These requirements have been met in the Pit River development by the selection of two 35,000-kva. generating units at the Pit River No. 1 plant, either of which will handle one 200-mile circuit, with the initial installation of one 20,000-kva. synchronous condenser in each of the substations.

Construction work on the project is well under way. Hat Creek power plants No. 1 and No. 2, each with 12,500 kva. installed capacity, will be in operation in the spring of 1921. The equipment for Pit River No. 1, of 70,000 kva., has been purchased, and it is planned to have it in operation by the end of 1921. Construction of the first 60 miles (96 km.) of line, which will permit a temporary tie with the existing system at 60 kv., is well under way, and contracts are now being placed for the equipment of the rest of the line and the substations.

The year 1920 will pass into history as the year in which the first 220,000-volt transmission projects were started. This work will show its importance in the accomplishments of 1921 and 1922 already planned.

Rating and Reliability of Electrical Apparatus Increasing

Single-Phase Transformers of 23,600 Kva.—Tests Justify Use of Pin Insulators in Horizontal Position —Vertical Break in Air-Break Switches

BY M. M. SAMUELS
Electrical Division J. G. White Engineering Corporation

NO STARTLING discoveries or brilliant inventions have marked the path of progress in the electrical industry during the past year. Nor have new principles, methods or radically new types of apparatus been brought out. Rather, the tendency has been to elaborate and improve upon the known types of apparatus to make them safe and more economical. Transformers of 23,600 kva. have been put in service, while 45,000-kva. single-unit generating sets have become standard. Oil circuit breakers for 220-kv. service and low-voltage breakers having 1,500,000 kva. rupturing capacity are in process of development.

In the race for size the transformer has run a close second to the generator, 23,600-kva., 130,000-volt, single-phase transformers having been completed and now operating satisfactorily. The following data will give a rough idea of their size: Diameter, 10 ft. (3 m.); height over tank, 16 ft. (4.9 m.); height over bushings, 22 ft. (6.7 m.); weight with oil, 63 tons; weight of oil, 18 tons. The "oil conservator" may now be considered a standard accessory to a large transformer, since it has fully demonstrated its value in the saving of oil and the reduction of breakdowns. There seems to be a backward tendency in some quarters to design transformers for indoor service, although the place for them is out of doors or away from occupied buildings.

Along with the increase in generator and transformer sizes, suitable switches had to be developed for both enormous rupturing capacity and very high voltages, and it seems that the switch designers have encountered greater difficulties than did the generator and transformer designers. However, oil circuit breakers are now in the process of development having a rupturing capacity of 1,500,000 kva. at 13,000 volts, and if successfully produced these circuit breakers will represent a very creditable achievement. On the other hand, high-voltage oil circuit breakers are also being developed for 220,000-volt operation. These will be approximately 34 ft. x 18 ft. x 21 ft. (10.4 m. x 5.5 m. x 6.4 m.) and will require about 17,000 gal. (64,000 l.) of oil. Because of the enormous size already reached there is evidently a great field for the inventor to develop new principles in switching and perhaps new mediums to be used in place of oil.

INTERCHANGEABLE BUSHINGS FOR 220-KV. LINES

Great strides have been made in the design of bushings and in the tendency to standardize them so that it is now possible to interchange transformer and switch bushings for very high voltages. One type of bushing now being developed for 220,000-volt switches will be oil-filled and have a dry flash-over voltage of 660,000, which is below its puncturing voltage. The wet flash-over voltage will be 485,000.

The recent tendency in air-break switch design has been toward the vertical break, which promises to give better satisfaction in operation. Several new switches of this type have been brought out recently. A novel idea in air-break switches is the vertical blade switch brought out recently which adapts itself to simple station design when used for disconnecting purposes. Automatic air-break switches are gradually making their way into the industry, and as more opportunity shall be offered for their study their field of usefulness will no doubt be considerably enlarged. However, the air-break switch is still in its infancy and must be made the subject of study and have many improvements before it will be able to compete successfully with the oil circuit breaker for interrupting load currents.

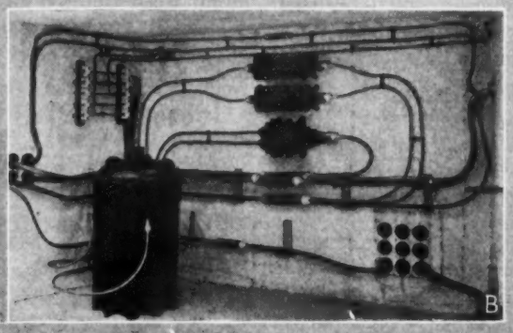
Insulators have of late been subjected to thorough study and laboratory research and valuable improvements have been made in their design. It will be of interest to many engineers to learn that it has been found through many independent tests that pin-type and post-type insulators have when mounted in horizontal position as great wet flash-over as when in upright position, if not greater. It is therefore no longer necessary to use the clumsy 45-deg. arrangement of insulators on vertical disconnecting switches, choke coils and bus runs, since it is perfectly satisfactory to install insulators in the horizontal position.

Some standard as to the meaning of the insulator rating of apparatus such as switches, choke coils, etc., should be established to enable a purchaser to know definitely when purchasing a switch just what flash-over tests and mechanical strength to expect of the insulator supports. At the present time some manufacturers use, for instance, the same insulator on 33,000 volts as others use on 22,000 volts, a practice which should be changed if the same margin of safety is desired.

Very little has been done along the line of developing practical mechanically operated disconnecting switches, even though the demand for them is continually increasing, since the many obvious objections to the hook type of switch are being more and more realized. Here, too,

Typical Methods of Meeting Service Requirements

A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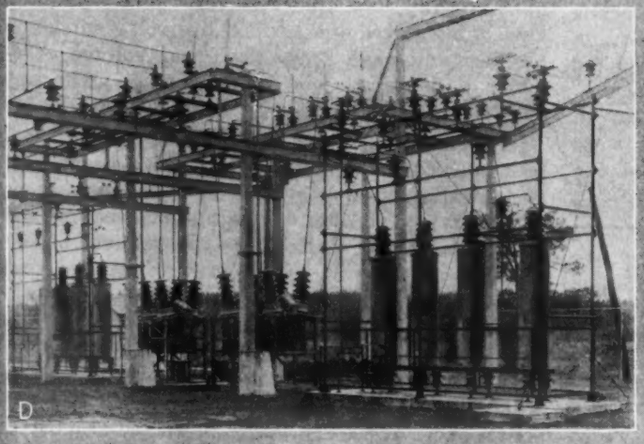
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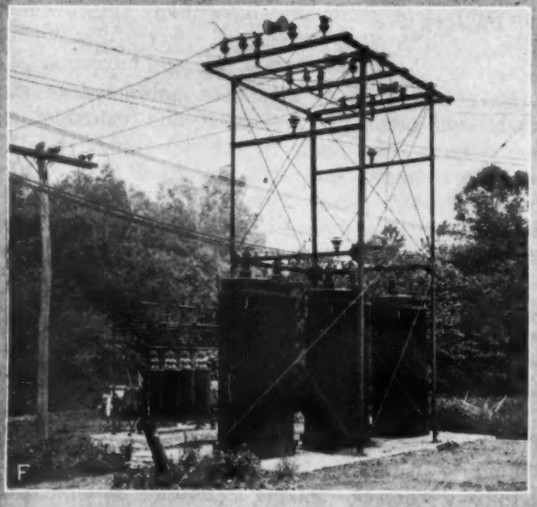
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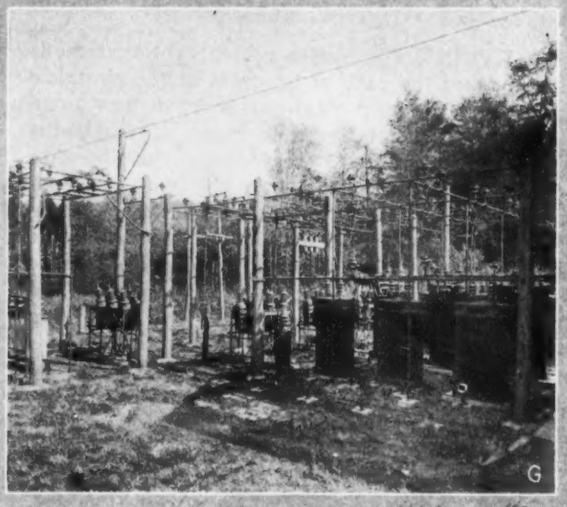
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A—Open-wire circuit connected with 26,000-volt underground cable by means of single-conductor cables and open-air potheads. B—Racking and arrangement of manhole cables with primary and secondary boxes and subway transformer. In the upper left-hand corner is the service bus from which connections are made to consumers. C—Vertical connection along pole from open-wire transformer service to underground conduit. D, F and G show recent tendencies in outdoor substation construction—the first with concrete poles, channel-iron bus supports and pin insulators; the second with angle-iron framework, vertical break disconnects and no sharp bends between line and arresters; the third with pipe framework on wood poles. Pipe framework is being used to the exclusion of other structural materials on all of the more recent installations. E—This illustration shows a 132,000-volt substation which is equipped with a high-voltage metering installation.

as is the case with air-break switches, a field of development is open to the inventor.

The super-generator of 45,000 kva. in a single unit has established itself definitely among standard apparatus. Several such units have been completed and put into successful operation, marking great economies in the cost of generation. There seems to be no tendency, however, to build these super-generators for higher voltages than the accepted maximum of 13,000, although there doesn't appear to be any reason why an attempt should not be made to generate at 22,000 volts or 33,000 volts.

No doubt there are some difficulties in taking proper care of slot insulation for these voltages, but at the present stage of development of insulating materials it should be possible to overcome these difficulties. Generator designers should also pay more attention to the way in which a large machine will be placed in the station and should provide greater accessibility to terminals than they have done in the past. Large generator terminals are generally brought out within the air duct, and with the types of steel foundations now in common use it is very difficult to provide neat connections from the switching apparatus into the air duct. The best that has been done along this line has been to provide holes in the steel foundation girders, placing micarte tubes in these holes and extending the generator terminals through the tubes from the air ducts to the outside of the foundation. The necessity of this procedure should be eliminated by proper arrangement of wiring at the machine frame. In the industrial field the tendency has been toward safety and economy. The dead-front switchboard, particularly the truck-type switchboard, is now in practical use in most plants where it is the purpose to have up-to-date electrical equipment. The dead-front type of switchboard has made it possible to use steel panels instead of slate, and there is reason to predict that in the near future slate switchboards will become a matter of history and steel panels will be used exclusively.

While many types of refillable fuses have been brought out, none of these may yet be considered to approach perfection. In developing new fuses it should be borne in mind that they must be so designed that the contacts are safe, that there should be not more than two or three parts to handle, that renewals should be possible without the use of tools, that there should be an indication on the outside of the size of the fuse, and that it should not be possible for any one to install more than one size renewal in a shell. Here is an opportunity for invention as well as for development. The tendency among engineers, however, is to eliminate fuses and to use circuit breakers wherever possible, and some very satisfactory oil circuit breakers with overload and low-voltage protection have been brought out recently. It is unfortunate that a clause slipped into the new National Electrical Code requiring fuses on motor circuits even when automatic circuit breakers are used. This ruling is an unnecessary hardship. After many years of discussion, and after having been in general use for years, varnished-cloth insulation has finally made its appearance in the code. To prevent rulings like the foregoing and the omission of necessary rulings practical engineers should take a more important part in the framing of the code, instead of leaving it to the arbitrary decision of inspectors.

In the near future another article will deal with progress in the high-tension field.

Effect of High Costs on Transmission and Distribution

Steel Cross-Arms Not So Attractive—Maintaining Live Lines—Economical Loading of Transformers—Sidewalk Distribution—Fiber Duct Favored

BY E. B. MEYER

Assistant Chief Engineer Public Service Electric Company of New Jersey

ABNORMAL credit conditions and the failure of rates to keep pace with the excessively high cost of material and equipment have forced utility companies to keep their financing for expansion and new construction down to the lowest possible figure consistent with furnishing adequate service. No extensive construction programs can be undertaken until prices of equipment have been reduced to somewhere near the pre-war level.

The interconnection of systems which was advocated so strongly during the war period is being carried forward, but not so rapidly as might be desired, owing largely to the financial situation. However, it is important to consider any interconnections which will result in saving fuel, since this material represents the largest element of the cost of producing electric energy. The difficulty of obtaining coal during the past year or two has made the matter of interconnecting power one of prime importance, as by this means service has been maintained which could not otherwise have been given.

The large amounts of power and the long distances involved in the interconnection of utility properties have made the study of the economic range of transmission voltage of considerable interest during the past year. As a result the feasibility, design, cost and characteristics of transmission at materially higher voltages have had particular consideration. The studies which have been made seem to indicate that the problems differ in degree, but not in character, from those which have been satisfactorily handled at lower voltages. In the studies of extra-high-voltage problems apparently the simplest design is the most desirable, and the elimination of unnecessary equipment tends to reduce the possibilities of service interruptions.

Voltage standards play an important part in interconnection, and for this reason the need of standardization is being discussed by engineers throughout the country. The advantage of keeping these standard voltage steps to a minimum is great, even more from the point of view of future interconnection than from that of economy of manufacture.

In the case of lower-voltage transmission systems the use of wooden poles rather than steel-tower construction seems to have been the general tendency. Some companies which have been using steel arms for lower-voltage transmission have seriously considered standardizing on wooden arms. The substitution of suspension strings for the strain insulators on transmission lines, with anchor towers on straight sections, also seems to be the general trend. The result of such a change is to reduce the number of insulator units which are in a horizontal position and thus reduce the percentage of total insulator failures.

The practice of maintaining transmission lines while alive seems to be gaining in favor, tools and equipment having been designed for changing insulators, carrying on new construction work and making repairs both to the line and other parts of the equipment.

All work is done without taking the line or circuit out of service, thereby effecting considerable saving.

Service connections to consumers represent a considerable portion of a utility company's investment, and on account of the high cost of labor and material in making such connections some companies have arranged to have the cost borne by the consumer either under a refund agreement or otherwise.

SELLING AT PRIMARY VOLTAGE

Within the last few years the development of numerous industries with large-scale production has made it desirable for a number of utilities to sell energy direct to the consumer at primary voltage, the consumer providing and maintaining all the transforming equipment and receiving the benefit of a differential in rate. Still others are continuing to sell energy metered and sold at the low-tension side of the transforming equipment, the utility providing and maintaining the apparatus.

Economical loading of distribution transformers to avoid the installation of unnecessarily large units and to prevent burn-outs is receiving close attention, and in many cases it has been found necessary to make tests in order to learn whether the transformers were being overloaded and subjected to undue and unnecessary strains. The need for a proper device to indicate automatically when the maximum safe loading of a transformer has been reached is evident, and the lack of an adequate method of checking and following the loads on transformers has resulted in many cases in the practice of installing larger transformers than are necessary. The practice of banking transformers is not so general as might be expected in view of the many advantages attendant upon such operation. This attitude is probably due to the trouble experienced in restoring service after a local interruption, but these difficulties are usually caused by indiscriminate banking without a sufficient study being made to insure a reliable and workable layout. The banking of transformers usually makes it easy to use fewer transformers of a larger size, thus resulting in a lower cost per kilowatt and a higher efficiency.

UNDERGROUND WORK DEFERRED

Like all other forms of construction, underground installations have so increased in cost that this branch of central-station work has been deferred wherever possible. It is unreasonable for municipalities to expect utility companies to continue extending their underground installations in the face of prohibitive costs, and it therefore is desirable that the two interests co-operate with the view of deferring such work until financial conditions are more favorable. Where it has been necessary to connect consumers from existing underground systems various schemes have been employed for reducing the cost. One of the methods employed where the streets have improved forms of pavement is to use a sidewalk distribution system with hand-holes near the curb as distributing boxes.

In connection with the heating of cables, proper design of conduit systems plays an important part; hence many companies in the past year have given considerable attention to the spacing and separation of ducts in the conduit runs to permit of proper radiation and also to prevent trouble in one cable from being communicated to a cable in an adjacent duct.

The use of fiber conduit is gaining in favor every day, and it is estimated that from 60 to 70 per cent of the companies are now laying fiber ducts in preference to other types of material. There are, however, some companies still continuing the use of vitrified-clay duct both single and multiple, while a number are also installing stone conduit. In making installations of fiber and stone ducts watertight joints are comparatively easy to obtain, but with vitrified-clay ducts, where the joints must be wrapped with cloth or paper and then covered with a cement or waterproofing compound, it is difficult and costly to keep the conduit free from water in wet or swampy ground.

Considerable interest has been shown during the past year in the subject of current-carrying capacity of cables. Many of the operating companies have been making extensive investigations with the view of learning more about the temperatures at various current ratings of underground cables. It is hoped that the investigations now being made by committees from a number of engineering bodies will be carried forward to some conclusive results in the near future.

LOWER DIELECTRIC LOSSES AND HIGHER VOLTAGES

One of the principal improvements in underground high-tension cables has been the reduction of dielectric loss at relatively high temperatures. This has been accomplished principally as the result of thorough study of the properties of impregnating compounds. It is now possible to manufacture cable the rating of which will be decreased only a few per cent at even 100 deg. C.

It seems highly probable that the proposed scheme of applying a metal sheath over the insulation of each conductor to improve the carrying capacity of the cable might be effective, not because of the reduction of dielectric loss, but because of the reduction of temperature of the insulation at the center of the cable due to the better thermal conductivity thus provided.

Temperature surveys of conduit systems to learn more about the heating of the cables are extremely important; therefore it is desirable that observations be obtained periodically so that relief may be furnished as soon as temperatures are found to be excessive.

The improvements in the manufacture of cables have been such that several companies are now considering the operation of three-conductor cables at 33,000 volts, and it is expected that in the near future even higher voltages will be undertaken. Since there are inherent limitations to the development of the usual three-conductor cables at extra-high voltage, the use of single-conductor cables seems to have merits.

The general tendency in underground-cable practice has been to use cables of large size, thus making it necessary to increase the diameter of the conduit in all new installations. In the past 3-in. (7.6-cm.) duct was considered standard, while today 3½-in. (8.9-cm.) and in some cases as large as 4-in. (10.1-cm.) duct have been used. The advantage of the larger size of duct is that splices may be drawn into the duct, thereby permitting the use of short lengths of cables which would otherwise have to be junked. This practice has been made desirable by the high cost of cable. In several cases it has been found necessary to reroute cables, and the duct splice has been a very desirable means of accomplishing this end most inexpensively.

Cable failures have been receiving more and more attention from year to year, and companies are now making investigations in order to analyze their failures

and put into effect measures which will prevent recurrence of such troubles. The protection of cables from fire in manholes by the use of cement covering has become more or less recognized standard practice.

There has been much discussion of the distribution of voltage stresses in three conductor high-tension cable, and several companies have installed cable of the Hochstadter type. Some companies are continuing the use of split-conductor cable, which is an installation similar in principle to the Merz-Price and other English systems of balanced protection. The first cost of split-conductor cable and the higher cost of making joints and connections make this type of cable considerably more expensive than cable of the usual design, hence its installation is not justified in all cases.

However, split-conductor cables give service as good as that of the usual type of cable, their only disadvantage being that for a given conductor size they are slightly larger in diameter. For tie lines between generating stations where it is of extreme importance to maintain service, and where faulty lines should be tripped out with the least possible disturbance to other lines and equipment, this type of cable is very satisfactory. Split-conductor cable is also desirable for loops fed from a generating station at one end and running back to the generating station at the other end, since in this case service to the substation is generally of prime importance and the ordinary relay has not a sufficient setting for safe use.

It should be borne in mind that for tie lines between stations to obtain the benefits of split-conductor cable—namely, uninterrupted service and disconnection of a faulty line with no resulting disturbance—there should be installed two or more cables, so that with the disconnection of one line the others will carry the load.

Aërial cable has been found very satisfactory, and its service has been extended considerably in the last few years because it has been found to meet certain needs in electric power transmission where underground construction costs are prohibitive and open-wire construction is undesirable. Its use has been confined, however, to special work, such as under bridges and over railroad crossings. In certain localities where high-voltage lines have to be run through trees aërial cable has been of decided advantage.

Superpower Investigation Between Boston and Washington

Engineering Organization and Nature of Studies Undertaken, Together with Some Aspects of the Investigation as Thus Far Made

BY W. S. MURRAY
Chairman Superpower Survey

IN JUNE of 1920 Congress passed a bill appropriating $125,000 to the United States Geological Survey for conducting power production and distribution studies in the United States, including a power survey between Boston and Washington. The plan proposed by the writer and assigned to him for execution in detail has for its central idea the construction of a regional power system with which to generate, transmit and distribute electrical energy to the railroads and industries within a territory the major limits of which are Boston on the north, Washington on the south and a point inland from the coast approximately 150 miles. Within this zone there is a present total demand of approximately 17,000,000 hp., 10,000,000 hp. for the industries and 7,000,000 hp. for the railroads.

Owing to the existing situation of unassociated power developments for the industries and railroads, the load factor (the ratio of average power to maximum power) in the zone is excessively low, and because of the small average size of central stations and the extremely uneconomical use of fuel by steam locomotives the waste of coal is prodigious. Thirty million tons is a conservative estimate of the annual waste of fuel, and this total is growing rapidly because of increasing power requirement, so that in 1930 the waste, if present methods are pursued, will reach the enormous figure of 53,000,000 tons.

The proposed regional plant will be electrical, and through its higher operating efficiency this great amount of coal can be saved and many economies in other materials and labor effected. The Superpower System comprehends the installation of large, economical steam electric plants, to be erected at tidewater points and at the mouths of mines where condensing water and other conditions permit. These steam stations will be supplemented with large hydro-electric plants, to be installed on the major rivers within the zone or within transmission distance of it. Such an assembly of plants severally connected to a system of transmission and distribution will serve the whole zone with adequate, reliable and economical power, relieve the railroads of the task of transporting the coal heretofore wasted, and also turn a large amount of the remaining coal tonnage, used for power and lighting, into electrical energy, and through the proposed electrical overhead carrier system of power again lessen the coal burden imposed upon the railroads and automatically release the new cargo space so badly needed for other commodities. The engineering organization authorized July 1, 1920, to make the investigations under the auspices of the United States Geological Survey was shown diagrammatically in the issue of the ELECTRICAL WORLD for Aug. 28, 1920 (page 447). It consists of an advisory board and an engineering staff.

The engineering staff, consisting of the chairman, three division engineers covering respectively power and transmission, railway and industries, the chief hydraulic engineer of the United States Geological Survey, the chief mechanical engineer of the United States Bureau of Mines and an engineer-secretary, with their several assistants, was duly appointed and in action prior to Aug. 1. Nearly all of the present twelve members of the advisory board had also accepted service on that date, and the board has since held two meetings. During the first two months weekly engineering staff meetings were held. More recently these meetings have been held at two-week intervals in order to afford more time for the receipt of analyses and assembly of data from the field in response to the information sheets which were sent out to the railroads, to industries and to central stations.

At this point I shall shed modesty and claim credit for the suggestion that an advisory board should be appointed, with recommended members appointed by the Secretary of the Interior. This board as now composed includes men of national reputation, who, although their minds are basically of an engineering cast, are serving the survey in matters pertaining to executive procedure. To my mind it was not enough, well surrounded as I am

with engineering talent, to allocate to myself or to these engineers the many problems that are allied to, yet quite separate from, engineering. I firmly believe that no man is a real engineer who does not relate law, finance, corporate relations and so forth to his problems; but with the wealth of talent now comprised in the advisory board ready at hand, interested and willing to assist in the solution of this great national power problem, I could justifiably have been charged with professional negligence had I not availed myself of it.

I have had the pleasure of addressing a number of engineering societies, organizations and chambers of commerce, and many questions have been asked. Some of these, together with others that have been asked by the editors of the ELECTRICAL WORLD, are quoted in the following paragraphs, with such answers as I find it possible to make at this time:

Is your plan in building the Superpower Zone to use existing power plants and lines as a nucleus, enlarging or strengthening where necessary, or is it to build superpower stations which will supplant existing large stations?

The plan of the Superpower System is to consider the building of new and very large stations, which may be of the order of 300,000 kw. None of these suggested stations will supplant stations now built whose inherent economies of operation are equal to the proposed new ones. The Superpower System might well be likened to a "university of power," matriculation in which will be the passing of an examination in economics of power production. As an example of a station not to be supplanted, take the station now being built at Hell Gate by the United Electric Light & Power Company in New York City. The thermal efficiency of this plant will be such that a kilowatt-hour will doubtless be placed on its main buses at an expenditure of energy not to exceed 17,000 B.t.u. Such a station, if agreeable to the operating company, will form a direct part of the Superpower System, and it is easily within expectation that the Superpower System will receive rather than deliver power to such a plant. On the contrary, there are many other and very large power stations whose economy of power production is less than those in New York City, and these should receive power upon their buses from the Superpower System. It will be of general interest to know that a committee has been appointed known as the "committee on power interchange," the chairman of which is John W. Lieb, vice-president of the New York Edison Company. I am asking this committee to make recommendations concerning power delivered to or received by the Superpower System in its relation to existing electric utilities. Service on this committee with Mr. Lieb has been accepted by representatives of both large and small public utilities within the Superpower Zone.

Many of the large systems, while their station efficiencies may not be the equal of that of the Superpower System, will contribute their quota in the form of capacity required during peak-load operation. The load factors of peaks is amazingly low, which means high capacity but low energy demand. The chief cost in a peak kilowatt-hour lies in the investment. An enormous reduction of this investment is gained through the use of hydro-electric plants where opportunity of storing water is possible. There are a number of places within the Superpower Zone where this principle can be applied. It is of interest also to note that, although the Eastern section of the United States has a smaller percentage of water power than the Western section, by proper application it can be made enormously effective in the reduction of investment cost. This fact and the application of diversity factor will permit a wonderfully economic intercorporate operation where so many plants may be associated. In short, the Superpower System motto might be "Competition with none, help to all." It is nothing more or less than a great economic pool of power, the functions of which are two: (a) the reduction of the cost of a kilowatt; (b) the reduction of the cost of a kilowatt-hour. When these two ends shall have been accomplished the national aspect of the scheme becomes immediately apparent from the resulting conservation of the natural resources of the country (coal) and of money.

Where are the most likely sites for new superpower stations?

Data to the extent of 80 per cent of the information required are in the hands of the survey, and co-ordinate analysis is now under way. At this writing it is impossible to state definite locations of the proposed new superpower stations. The report will include recommendations relating to the size, the location and time of location of transmission lines, substation and superpower stations.

Which existing large stations will form the foundation of the zone?

The large stations now in operation in Boston, Providence, New York, Newark, Philadelphia, Baltimore and Washington and such others as may qualify for base or peak-load operation will form a part of the Superpower System.

Is it your contention that 220,000-volt lines will be required merely to exchange energy between adjacent plants?

No; the 220,000-volt lines will be associated only with power transmitted from the more distant points, as from the St. Lawrence River or the coal mines. The zone transmission voltage will be at a lower potential, possibly employing 110,000 volts. While the central stations will supplement each other, the clearing house for this exchange will be the substations. It will be only in exceptional cases, though the operation is perfectly possible, that power stations will exchange power.

Will the Superpower System consist of a trunk line or merely a heavy network between the larger stations with laterals to connect other systems?

The Superpower Zone is not so extensive but that a ring bus carrying a potential of 110,000 volts may be entirely sufficient to carry loads within the range of commercial loss. These loads can be supplemented, as explained in the answer to the preceding question, by power transmitted from distant points at 220,000 volts and stepped down to zone voltage.

What investigations have been made so far to determine feasibility?

There is nothing untried in the proposed system except possibly the art of the complete co-ordination of so many systems. A central control system whose functioning head will be a load dispatcher will, of course, be necessary, but no particular difficulty is anticipated on a wider extension of the principles now in operation.

How do existing central-station systems feel toward the plan?

If interest and assistance are indicative of their feeling, I would say it to be most friendly. My report indeed has been made possible only by the hearty co-operation I have received from the public utilities, railroads and industries.

How do the companies in the vicinity of Niagara Falls feel toward the project of connecting with such a system?

No discussion has yet taken place concerning the Niagara companies. If power in excess of the immediate local requirements is available in this zone, the radius of transmission for large blocks of power is within commercial transmission distance. Niagara Falls is practically the same distance from New York as the St. Lawrence River.

What certainty is there that railroad electrification loads can be secured in the near future?

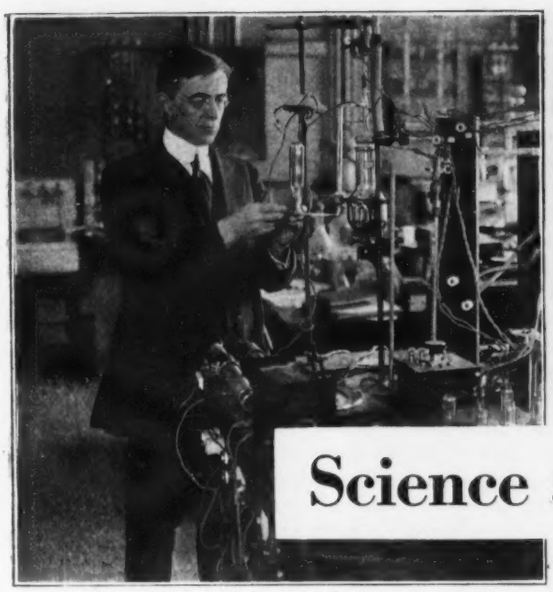
Of the railroads in the zone, about 6,000 miles (single-track basis) indicates a density sufficient for immediate electrification.

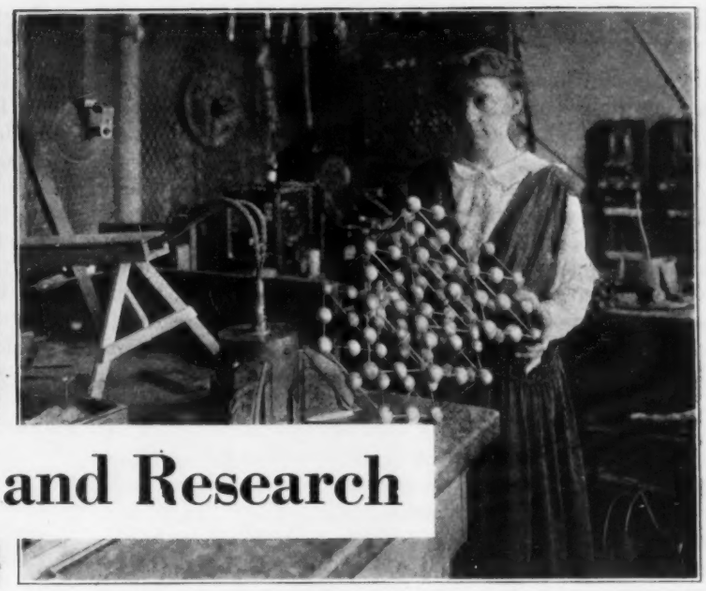
Can you indicate the magnitude of load expected within two years after completing the system?

For the Superpower Zone the data so far received indicate the following electrical loads: 1920, 12,500,000,000 kw.-hr.; 1930, 36,400,000,000 kw.-hr.

What conclusions have been reached so far?

At this writing, since much of the data are yet to be analyzed, it is thought inadvisable to offer any conclusions. I find, however, that so far I have no reason to depart from my earlier estimates regarding the density of power requirement within the zone, nor any reason to believe that an electrical regional plant of the character described will not effect the economies predicted.





Science and Research

Electromagnetic Theory Is Fundamental in the Sciences

Reaches Pinnacle of Usefulness in One Hundred Years —Langmuir's Postulates and Einstein's Theory Are Being Tested.

BY A. E. KENNELLY

Professor of Electrical Engineering Harvard University and Massachusetts Institute of Technology

THE year 1920 has been notable in scientific annals as being the centennial of the first discovery of electromagnetism through the classical researches of Oersted and Ampère. We who live in this century are accustomed to see great industrial power plants, having large electromagnetic generators, motors and connecting lines, with their electric and magnetic fields in co-operative association. We are also familiar with the emblem of the American Institute of Electrical Engineers, which shows a magnetic circuit ring linked rigidly with an electric circuit ring. It is difficult for us to realize that prior to 1820 there was no recognized association between magnetism and electricity.

A noticeable feature of the scientific literature of the past year has been its phase displacement. Owing to the effects of the world war we have been many months in arrears of publication. Work done in applied and unapplied electrical science during the period of the war and held back from dissemination for various reasons connected with that greatest event of modern history is only now being released, examined and discussed. Nor is this time lag discernible only in electromagnetic literature. It clearly pervades all scientific literature. All whose tasks are connected with science in some branch or application, which today includes a large share of the entire community, are now called upon to make a greater mental effort of readjustment than formerly in order to bring themselves once more into synchronism with the creative effort of the day.

But if the greatest of all wars has left the world depleted materially and with a harder task in maintaining pre-existing standards of material comfort and intellectual satisfaction, it has also left the world in much closer national association. The fact that the most distant antipodal regions are probably only one-tenth of a second remote by radio has come to stay with us and to influence our lives in ever-increasing ratio. The world war has destroyed national isolation, and we find ourselves compelled to think in international terms. The recent official opening of the great Lafayette radio station at Bordeaux is a typical event of the year. It marks the satisfactory completion of a co-operative electrical engineering plant, the daily operation of which will make itself audible not only in America but all over the globe.

Electromagnetic researches are now so comprehensive in their scope that they may be regarded as including, from a broad standpoint, nearly all of the scientific researches comprised within the original meaning of natural philosophy. Chemistry, mechanics, light, heat, and now even gravitation, are claimed as branches of electromagnetics. Perhaps the most recently active field of electromagnetic investigation has been physical chemistry, on the border line of atomic theory. The interest in atoms has been directed to their constituent electrons. It is curious that the electron, which has been so prominently occupying scientific attention everywhere, is an entity having a mass of less than 10^{-27} gram. The number of electrons in a gram of matter is therefore estimated at more than 10^{27}. A convenient method of visualizing a large number of this kind is to consider the size of a cubical box necessary to contain that number of small shot. An ordinary diameter of small bird shot would be 1 mm. On this basis shot would be 10^9 mm., or 10^6 m., or 10^3 kg., in length the cubical box that would be necessary to hold 10^{27} shot would be 10^9 mm., or 10^6 m., or 10^3 km., in length of edge. It would be about as long as the distance from Norfolk, Va., to Ottawa, Canada. Albeit a gram of matter is supposed to hold that number of electrons, these are not believed to be tightly packed, like shot in the hypothetical box. On the contrary, the average distance between adjacent electrons must be very large compared with the dimensions of each electron. The electron is at present the smallest thing known to exist, and is about fifty thousand times smaller in "diameter" than the hydrogen atom, which, in its turn, was the smallest thing recognized in science a generation ago.

Since the experimental researches of Millikan have enabled us to study the behavior of individual electrons and to count them one at a time like coins, the belief in the existence and properties of these most minute electrics of the under-microscopic world has made great

advances. Chemical affinities, forces and combinations are assumed to be the stories of the properties and propensities of electrons in their various organized atomic groups.

The recent brilliant investigations of Bragg and Moseley have led to the belief that the eighty-eight known chemical elements, from hydrogen to uranium, occupy a series of simple atomic numbers from 1 to 92 inclusive, with only four missing or unidentified members. To each of these atomic numbers belongs, according to theory, a like number of nucleus electropositive charges and a like number of electronegative electrons.

LANGMUIR'S POSTULATES OCCUPY SCIENTISTS

A very interesting recent theory of Langmuir deals with the constitution and construction of the various eighty-eight chemical elements. Each kind of atom has a three-dimensional structure, approximately spherical in form. The polar axis of an atom is an axis of symmetry, and the equatorial plane perpendicular thereto is a plane of symmetry. By building up spherical aggregations of one, two, three and four units in radius, with "cells" of equal size apportioned among the different electrons, the theory claims to account for a number of the known chemical properties of the different atoms and to satisfy the periodic series originally pointed out by Mendeléeff.

Langmuir's spherical atoms are actually more easily worked with as cubes. The atoms are chemically inert when the number of electrons is such as form simple stable groupings of positive nuclei and negative electrons evenly divided over the surface. Thus, neon with two electrons and helium with $10 = 2 + 8$, two in the inside and eight in the outside shell, are the first two of the highly inert atoms. When, however, the atomic numbers do not fill up the outside shells forces are exerted on neighboring atoms to bring about a structural union, or chemical combination, that will complete octet groups of electrons between them. In this manner a very fascinating stereochemistry is worked out for a number of atoms and molecules, which is purely electromagnetic in one aspect, purely chemical in another and purely structural in a third.

The Langmuir theory offers so many opportunities for examination and discussion over an enormous field of bald chemical facts, which have hitherto for the most part defied explanation, that it will take the chemists a long time to come to a decision as to the final place of the theory in the general field. It is difficult to decide at first sight how atoms in a given molecular combination behave toward each other on this electron hypothesis. It is advantageous to construct mechanical models of the various component atoms and to study the ways in which these can be brought into mutual contact, with the maximum stability and structural simplicity. The theory is built upon eleven postulates and offers a new view of chemical valences.

EINSTEIN'S THEORY APPEARS WELL FOUNDED

Another subject of investigation which has assumed great scientific prominence during the past year is the Einstein theory of relativity in its latest form. Indeed, the interest in this scientific subject may be said to have overshadowed almost all others during recent months. The theory is admitted to involve three consequences, capable of being experimentally verified and not otherwise explainable—namely, first, a slow rotation of a planetary orbit, which in the case of Mercury takes 140 years to advance through one minute of arc, or 3,000,000 years to complete one revolution; second, a bending of light in a powerful gravitational field, as though the light were ponderable material, and, third, a minute displacement of the spectral lines of the sun toward the red end of the spectrum. The first two predictions are declared to have been already verified, while the third is still undecided.

As to the consequences of the theory, they may be regarded as at present unrecognizable to the ordinary observer, inappreciable in engineering or geodesy, appreciable in astronomy, but of very great significance in philosophy or the doctrine of the universe. The remarkable fact, from an electromagnetic standpoint, is that the new space geometry, which is no longer simple Euclidian three-dimensional geometry, is claimed to be in complete conformity with the Maxwellian theory of the electromagnetic field. According to this doctrine, space is not infinite, but very large and limited; gravitational force is merely a fictional phenomenon, due to our misinterpretation of the vagaries of geometrical space in the vicinity of matter, and time is indissolubly linked with space. While it is not difficult to obtain an abstract comprehension of this doctrine, on the basis of mathematical equations, it is extremely difficult to obtain a concrete comprehension that can be visualized or constructed. It is pointed out, however, by the protagonists of this remarkable theory that we have no right to deny its validity merely because we have difficulty in visualizing it to our untrained senses.

Insulator Progress During 1920

A Review of Important Research Work Now Under Way —Requirements for 220-Kv. Transmission Lines— Insulator Failures Resulting from Lightning— Fundamental Developments in Insulator Design

BY HARRIS J. RYAN

Professor of Electrical Engineering Leland Stanford, Jr., University

THE year 1920 will be distinguished for the determined efforts that have been made in studies of transmission-line insulation to insure operating reliability, to develop greater durability of insulators and to find forms that should be satisfactory for the support of 220-kv. lines. In respect to design there has been considerable authoritative effort to overhaul the analytical work of ten years ago in order to profit by a more modern knowledge of fundamentals. In this the manufacturer has welcomed the cordial co-operation of the operating engineer.

Along other lines a notable work of co-operation was accomplished by the ELECTRICAL WORLD* in obtaining practical data from the engineers of forty-one power companies operating high-voltage transmission lines in the United States and analyzing and publishing them. The companies permitted their names to be published with the data and answers supplied by them. In the judgment of the writer this is the most important single insulator achievement of the year.

The National Electric Light Association has an insulator research committee at work on the problem of the

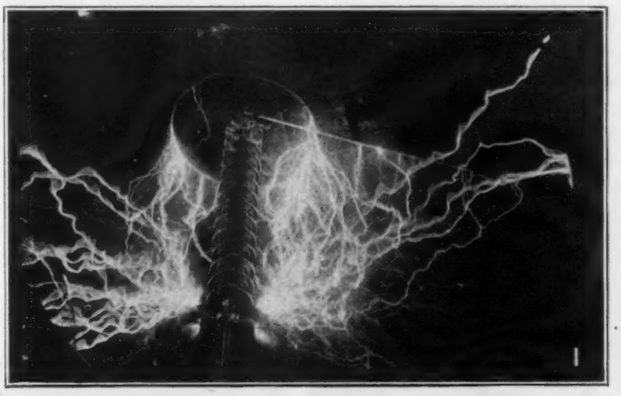
*"Analysis of Insulator Practice," ELECTRICAL WORLD, March 6, 1920, page 543; March 13, 1920, page 596; March 20, 1920, page 673.

durability of suspension insulators as affected by temperature cycles. The association is financing the undertaking. This committee has developed and is maintaining in operation equipment by which five twelve-unit strings sustaining individual mechanical loads varying from zero to 5,000 lb. (2,267 kg.), as desired, are carried through 150 temperature cycles each week. The temperature ranges run upward from room temperatures to temperatures not exceeding 130 deg. Fahr. The automatic "ovens" have been put to work on specimens collected for this purpose in 1917. The work as originally undertaken was interrupted by the war. With the knowledge and experience gained through the 1917 material, specimen products of the latest state of the art will be put through presumably 1,500 cycles under appropriate mechanical loads.

Revision of Insulator Specifications

The American Institute of Electrical Engineers standards committee has also organized a sub-committee on insulators that is engaged upon a revision of insulator specifications in response to a resolution passed at the Portland meeting in July. When the details of insulator requirements for the proposed 220-kv. lines were first considered a difficulty was encountered because of the excessive voltage duty that must be carried by the unit in the string next to the line conductor. It was generally conceded that the safe practicable limit had been reached at 18 kv. for the 10-in. (25-cm.) unit on 150-kv. lines. It was known that such voltage duty on the end unit of the conductor was likely to increase approximately as the line voltage, quite independently of the number of units that might be added to the string.

At a line voltage of 220 kv., therefore, the duty on the conductor end units would be 26.5 kv. when dry, and the corresponding factor of safety against general breakdown of the air surrounding it would be about three, whereas the corresponding factor of safety on the 150-kv. line is four and one-half. Eventually the majority of conductors in the 220-kv. lines may be too heavy to be supported from single strings of the 10-in. insulator units that are in common use today. Furthermore, reliable makers have come forward with tentative assurances that on demand larger units will be furnished that are capable of supporting the heavy conductors and withstanding higher end-unit voltage duties.



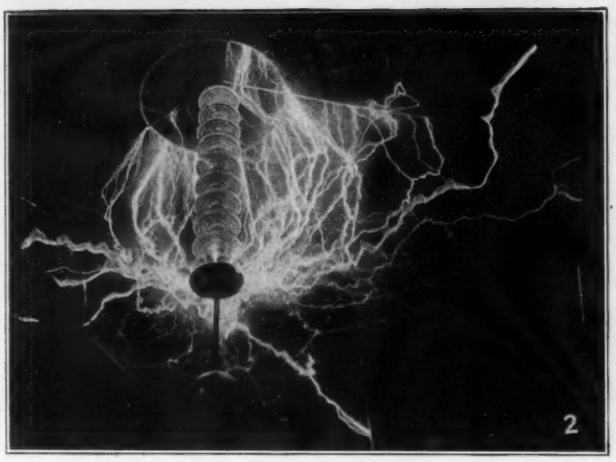


FIG. 1 — IMPULSING SUPERVOLTAGE CAUSING DISCHARGE ABOUT A FOURTEEN-UNIT STRING OF 10-IN. CAP-AND-PIN-TYPE INSULATOR UNITS. FIG. 2—IMPULSING SUPERVOLTAGE CAUSING DISCHARGE ABOUT A TEN-UNIT STRING OF CORE-AND-TINE-TYPE INSULATOR UNITS.

Nevertheless, the outlook today, like the outlook a year ago, is, in effect, that the first 220-kv. line to be tried out will not be too heavy for support with single or double strings of common 10-in. units. Accordingly the year has witnessed a determined co-operative effort in various quarters to determine upon the manner in which ordinary suspension insulators may be used satisfactorily for the support of the proposed 220-kv. power lines. These efforts have resulted in a crop of technical papers and reports to committees, with the attendant discussions, indicating that excellent progress in this regard has been made. The earlier discussions developed the fact that knowledge of the flash-over characteristics of long suspension insulator strings was lacking in many essential respects. One of the National Electric Light Association committees has undertaken to obtain an understanding of these characteristics in definite terms. Progress is being made.

Three Types of Flash-overs Being Studied

In general three types of flash-overs are being studied: (1) Impulsing supervoltage (by oscillator at 75,000 cycles); (2) 60-cycle flash-over voltage; (3) disturbances started by foreign conducting or ionized material on the insulators or the conductors or in the air about them. In the first of these studies it has been found that in the short strings of two to seven units, wherein the unit-voltage duty distribution is excellent, cascading occurs during flash-over; that as the string is lengthened to ten units the cascading is greatly diminished, and that it is virtually absent for strings of greater length. This has been found to be true regardless of the type of unit. The characteristic behavior in this respect is the same for the cap-and-pin units having the higher capacitance as for the core-and-tine type having the lower capacitance.

The results so far obtained indicate a decided superiority of the long over the short suspension insulator strings in the matter of flash-over characteristics under impulsing supervoltage. In this flashing over long strings it has been observed that the tower cross-arm end units are occasionally cascaded by "in-shoot" flashes. This may or may not be caused by the surface charges referred to below—a matter that is being included in the studies.

The studies of this committee include also a set of

fundamentals about which little is as yet known and that attain importance when the 220-kv. line is under consideration. These are: (1) The character of discharge-route options that exist in all ordinary circumstances for impulsing supervoltage transients because of the now known nature of the process by which discharges must begin, extend and culminate in flash-overs; (2) the strength and figure of the main electric field about an insulator as factors in the control of routes of discharge produced by steep-wave-front supervoltage transients; (3) the magnitude of corona formation and dissipation of energy along the transmission-line conductor during the brief interval required for a supervoltage transient to form and extend an isolated flash sufficiently to cause flash-over to cross-arm or tower, through lightning arresters or over bushings to ground. Little has been known heretofore as to why will not be easily won. The circumstances indicate the importance of team-work on the part of the engineer and the manufacturer to develop the most suitable type of insulator to meet this sort of duty, and on the part of the engineer and his management to institute the kind of care and maintenance that will obtain the best results in the end.

Studies in Unit-Voltage-Duty Control and Super-Voltage Flash-overs

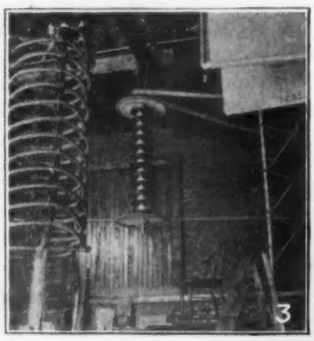


FIG. 3 — LABORATORY SET-UP OF A DOUBLE TWELVE-UNIT STRING OF CAP-AND-PIN-TYPE INSULATOR UNITS WITH LARGE DISK SHIELDS FOR THE STUDY OF THE CONTROL OF UNIT-VOLTAGE DUTIES

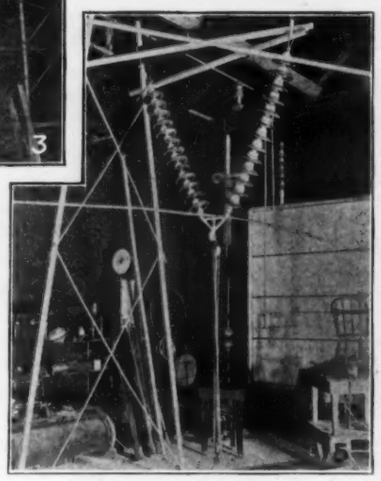


FIG. 5 — A DOUBLE THIRTEEN-UNIT V-STRING OF COMMON TYPE UNITS BEING STUDIED WITH RESPECT TO THE REQUIREMENTS OF THE 220-KV. LINE

FIG. 6 — SUPERVOLTAGE FLASH-OVER STUDIES OF THE SPECIMEN IN FIG. 5, EXCEPT THAT "PICK-UP" SHIELDS HAVE BEEN ADDED

The discharge route options in this case are particularly interesting. In 32 flashovers, two struck 84 in. to the wall, twenty-seven struck 51 in. (minimum) to the cross-arm, and three struck 49 in. (minimum) to tower members. The studies include electrode fittings formed to prevent the start of flashes until the main fields have been built up sufficiently to be controlling in regard to discharge routes.

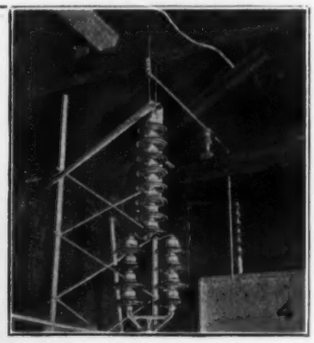


FIG. 4 — ONE OF MANY LONG SUSPENSION-INSULATOR FORMS BEING STUDIED FOR UNIT-VOLTAGE-DUTY CONTROL. NOTE THE TWO SETS OF INSULATORS USED AT THE LINE END OF THE STRING.

supervoltages can be thrown onto a transmission line in huge amounts sufficient to break through great air columns with apparently little dissipation of energy in corona formation about the conductor.

The questionnaire submitted by the technical press already referred to and the returns that were published reveal with a certainty the many positive factors that enter into the construction, erection and maintenance of high-voltage line insulators. There are in the returns important lessons for all concerned. For instance, a nation-wide effort should evidently be made to educate hunters and all users of the rifle to understand that the destruction of line insulators means the wanton interruption of a vital service rendered to large communities.

The returns also emphasize the serious difficulties caused by the dust that settles upon insulators in many localities and which may be rendered highly conductive when moistened by fog or dew. The final victory here will not be easily won. The circumstances indicate the importance of team-work on the part of the engineer and the manufacturer to develop the most suitable type of insulator to meet this sort of duty, and on the part of the engineer and his management to institute the kind of care and maintenance that will obtain the best results in the end.

LIGHTNING AGAIN INDICTED AS GREAT FACTOR IN CAUSING INSULATOR FAILURES

Lightning is again indicted as a great factor in causing insulator failures in many localities. The year has witnessed some real progress in minimization of damage to insulators and insulations from this cause. It has been pretty well demonstrated that damage by lightning is at a minimum on extra-high-voltage lines that have been liberally insulated. Granted that the 220-kv. lines are carried on string lengths of thirteen or more units, the expectation is warranted that the magnitude of bound charges will rarely be sufficient to cause flash-overs when released by neighboring lightning strokes, and that troubles due to other factors, such as switching, transients, wet dust or other foreign material, will be correspondingly diminished. The known characteristics of long suspension-insulator strings when equipped with appropriate shields support this contention.

One engineer related that the progress of a lightning storm over his transmission lines could be noted by the slow transients recorded by the ammeter in the neutral-to-ground connection in the main generating station. His explanation was that, his lines being well insulated, the release of bound charges did not in general produce a sufficiently high potential to flash over the insulators in the neighborhood of their origin, and that they spread over the lines and were

drained to earth through the grounded neutral at the generating station.

The extensive lightning investigation in the Chicago area has demonstrated the value of "arrester density" and the protective effects of overtopping trees, buildings and all similar shielding structures in eliminating damage by lightning on transmission lines operated at the lower voltages, that is, 11 kv. to 66 kv. The engineer in charge of lines of this class in lightning districts can now confidently count upon the value of overinsulation, increased lightning-arrester density and well-arranged ground cables to cut down the frequency of interruptions due to lightning and thus to increase the reliability of service from his lines.

Effect of Alternating Fields on Dielectrics Surrounded by Air

In conclusion, there should be mentioned two outstanding fundamental developments in insulators that the year has brought forth. Nishi ("Surface Creepage and High-Voltage Insulation," *Journal A. I. E. E.*, November, 1920, page 949) has shown that surfaces of dielectrics surrounded by air become highly charged when subjected to strong alternating electric fields in which there is local corona formation, *i.e.*, a local source of ions.

Aside from the presence of ions, the essential factor in the production of the unidirectional surface charges is the component of the electric field that is normal to the surface. Obviously the effect is to cause a breakdown of the air columns adjacent to the dielectric surfaces at lowered voltages. The results enhance the importance of the Fortescue principle ("Air as an Insulator," *Transactions A. I. E. E.*, Vol. XXXII, page 893, 1913), whereby solid dielectrics which are used to avoid overstresses in the air about high-voltage electrodes must be so formed that their surfaces in contact with the surrounding air will everywhere be parallel to the Faraday tubes of electric force that pervade the zones of air and solid dielectric adjacent to such surfaces.

Because in an actual case it is often difficult to eliminate all corona formation when the insulator is subjected to its highest voltage duty and the application of the Fortescue principle is not often completely feasible, it then follows that insulator design must to a high degree remain an art as well as a science.

Advantage of Glass as a Conductor in Precipitation Treaters

The other outstanding fundamental development is likewise remarkable and was also developed in Japan. Shibasawa and Niwa ("A New Electrical Precipitation Treater," *Journal A. I. E. E.*, October, 1920, page 890) have shown that glass can be used to advantage as a conductor, having the resistivity requisite for the control of the density at which high-voltage direct current passes from the surface of the central cylindrical electrode of a dust precipitator. Ordinarily the current is allowed to pass from the bare metal surface of the central electrode. The action then becomes stabilized in a highly irregular distribution of density of exit of the precipitation current from the surface of the electrodes, which causes the electrodes to "foul" too quickly.

Increasing Cable Rating Has Received Considerable Attention

A Decided Decrease in Dielectric Loss Has Been Effected and New Schemes of Dissipating Heat Are Being Tried—Problems for Future Research Are Outlined.

By William A. Del Mar
Chief Engineer Habirshaw Electric Cable Company

So rapidly has the use of electricity grown since the war that electric lighting companies have been embarrassed by the overloading of their existing cables and the difficulty of getting sufficient new cable to meet their growing requirements. Some of the companies are also operating under municipal restrictions which prevent the opening of streets for laying new ducts except at infrequent intervals, and for this reason means of increasing the current-carrying capacity per unit cross-section of ducts is of utmost importance. Recognizing these facts, cable manufacturers have cooperated with users in efforts to increase the current-carrying capacity of impregnated paper cables. These efforts have resulted in a noteworthy reduction of dielectric losses by the use of new impregnating compounds and in novel methods of carrying away heat generated in cables.

Five distinct lines of attack have been tried:

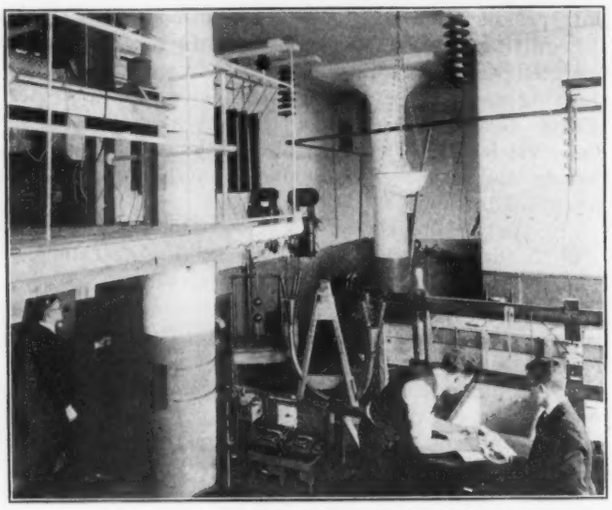
1. To decrease the heat developed in the cables by reducing the dielectric losses to a minimum.
2. To increase the heat-dissipating ability of the cables by affording special facilities for the escape of heat.
3. To increase the maximum permissible operating temperature of insulation.
4. To improve the heat dissipation from the outside of cables to ducts.
5. To install cables aërially on messenger cables instead of in ducts so as to obtain the benefit of a full circulation of air around them.

Such success has attended the efforts to decrease dielectric loss that users of cable may be less concerned about this loss than about the possibility that too rapid development in manufacturing processes may have led to the sacrifice of other equally desirable but less easily measured qualities. The big change which brought about a material reduction of dielectric loss was the abandonment of mixtures of resin oil and resin for impregnating the paper and the substitution of compounds composed principally of petrolatum and resin. The next step was the introduction of more thorough methods of drying the paper and both drying and purifying the compound. Then certain manufacturers introduced variations which at the present time may be regarded more or less as trade secrets. The net result is that cables may be purchased having a fraction of the dielectric loss common to cables purchased ten years ago.

The attempts to improve the heat-dissipating ability of three-conductor cables have met with considerable success, and at least one cable designed with this end in view is in successful operation. The most promising design consists of three paper-insulated conductors covered with copper tape and inclosed in a lead sheath. The copper tapes convey the heat out to the lead sheath. These cables have not been in use long enough to have established their merit, as questions of eddy-current

loss and the balancing of saving in first cost against increased energy loss have yet to be published.

Attempts to increase the permissible operating temperature of impregnated paper insulation have met with little success, as paper itself begins to deteriorate at a temperature but slightly above the A. I. E. E. limit of 85 deg. C. Some of the lighting companies find it commercially economical to operate their cables during the hours of peak load at temperatures which it is known would promote deterioration of the paper if maintained for long periods, but the aggregate duration of such periods of peak load may not be sufficient to cause serious deterioration. It is even suspected that paper will be less injured by numerous short exposures to high temperature than by continuous exposure to the same temperature for the same aggregate time. This, however, cannot be said to be definitely established, and, indeed, the contrary opinion is held by some—that such peak loads are particularly harmful. The companies which are operating their cables above 85 deg. C. have not, therefore, justified their practice on generally known scientific grounds. This question is to be discussed at the mid-winter convention of A. I. E. E.



EXPERIMENTAL TEST OF HIGH-VOLTAGE CABLE

The voltage test was made after bending at minus 10 deg. C. at the Habirshaw research laboratory. The 150-kv. transformer is in the far corner of the laboratory.

Important work has been done on the measurement of cable temperatures in ducts and on heat dissipation from ducts,* both in actual and experimental duct lines, which may form the basis of a new temperature standard. In any case this work has shown both the importance of designing duct lines with the view of maximum heat dissipation and the desirability of placing cables in duct banks in such a way as to get the greatest carrying capacity. Researches are also under way to determine the nature of the deterioration of impregnated paper at high temperatures.

While not exactly in the line of cable research, more attention is now being given to ways and means of dissipating heat from the outside of cables, and one engineer has gone so far as to suggest that ducts be filled with petrolatum in order to give better heat conduction from sheath to duct.

The use of aërial† cables insures not only the benefit of open-air conditions to increase the carrying capacity but also cheapness and rapidity of installation. Three companies make special types of cables for this purpose, but the success of the telephone companies with lead-sheathed aërial cables seems to indicate the construction that will be favored. Good work has been done in tracing fields of force and in ascertaining the dielectric stresses in triplex cables.

The present voltage limit, both in America and in Europe, for three-conductor cables is 30,000 volts to 33.000 volts, and for single-conductor cables 60,000 volts; but researches now under way indicate that higher voltages may be attained, with small conductors especially. This is contrary to the common view, which is based on the assumption that the dielectric stress at the surface of a conductor is greater the less the diameter of the conductor. The merit of the small conductors, from the point of view of dielectric stresses, lies primarily in the fact that the dielectric strength of ionizable insulation, such as impregnated paper, is greater in an electric field that dies off rapidly, like that around a small wire, than in a field that is comparatively uniform, like that around a large wire. Another factor, however, is that for analogous reasons the dielectric loss is less for a given charging current with a small than with a large wire. These matters are still in the laboratory stage.

Little has been accomplished in the line of improving rubber or varnished-cambric insulation, and no new types of cable insulation have appeared on the market. Varnished-cambric cables are now recognized by the National Board of Fire Underwriters, and manufacturers have improved them so that when used on vertical runs the "slipper" compound will not drip out.

Cable users can help development both by allowing the manufacturers to study their conditions of service and by adapting their conditions to permit the use of standard types of wires and cables. A recent handbook issued by a manufacturer shows he has calls for at least a hundred different standard types of wire and cable and for an average of about ten sizes in each type, or a total of 1,000 wires and cables listed. Besides these, there are thousands of different wires and cables on special orders. This condition affects the cable users most unfavorably and calls for some effort by them to reduce the number of special wires and cables required.

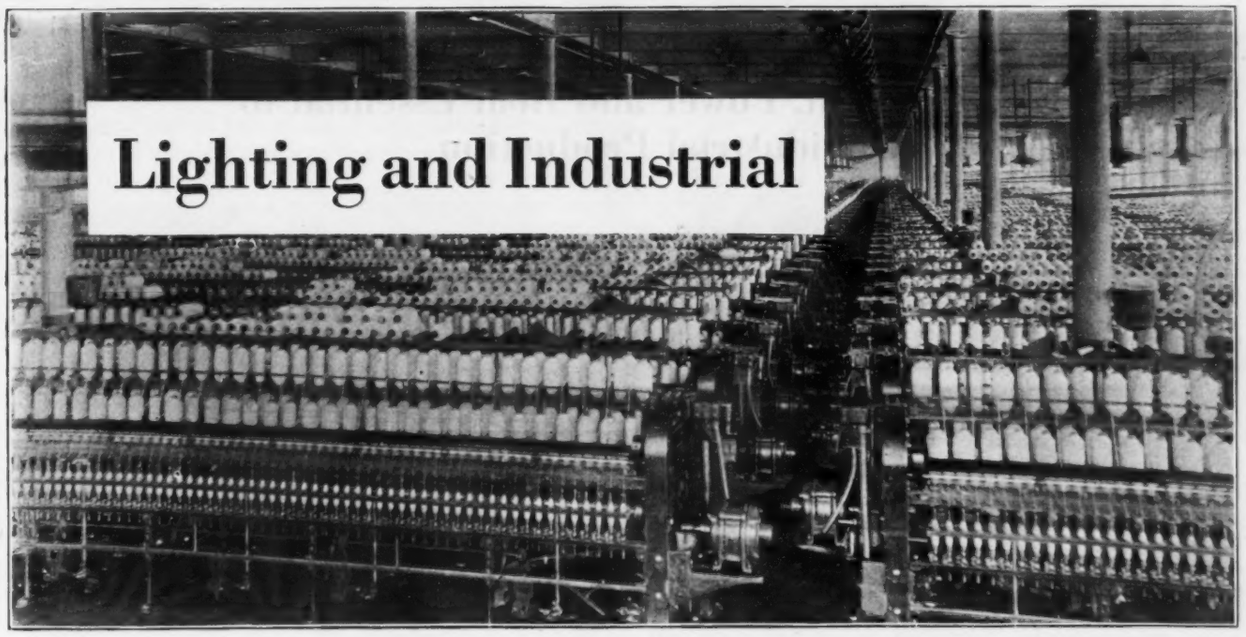
The obstacles that stand in the way of progress in cable design are as follows:

1. The low temperatures at which insulating materials deteriorate.
2. The low temperatures at which ionization occurs in impregnating oils.
3. The impossibility of obtaining the full benefit of the specific qualities of dielectrics, due to the low ionization voltage of entrapped air.
4. Growth of dielectric losses with increase of voltage.
5. High heat resistivity of insulating materials.

The formation of the insulation committee of the National Research Council promises to open a new era in cable research. While four or five cable manufacturers are well equipped with research facilities, most of the work they have done has been of a practical character, with but little pure science to serve as the foundation for a vast store of practical knowledge. Research on the nature of dielectrics, dielectric loss, ionization, conductance, etc., is badly needed.

*"Thermal Conductivity of Underground Ducts," by Willard S. Wilder, ELECTRICAL WORLD, Jan. 3, 1920.

†"Overcoming Difficulties with Aërial Cable," by E. B. Meyer, April 14, 1917.



Lighting and Industrial

Non-Ferrous Furnaces Becoming Very Attractive

Predicts Electrification of Three-quarters of Brass-Melting Industry in Ten Years—Power Distribution Lines Should Be Separated from Lighting Circuits

By Edwin L. Crosby

President Detroit Electric Furnace Company, Detroit, Mich.

THE electric furnace business has already become a substantial portion of the total load of a large number of central stations and if the companies will devote to electric heating of all types even a small measure of the energies expended during the last ten years to build up their motor load the results obtained will be equally gratifying.

The most important point for consideration in connection with this business from the central-station standpoint is the establishment of certain standards of distribution which will permit the operation of furnace loads amounting to from 250 kw. to 2,500 kw. in a single unit without affecting the power and lighting service by unbalancing the system. The largest utilities seem to have realized the advisability of establishing independent power circuits both for interurban transmission and local distribution. On such a system any furnace now in the market will operate with maximum satisfaction both to the user of the furnace and to the central station supplying the service. The inadvisability of connecting electric furnace loads to the same distribution system with commercial lighting has been pointed out in the technical journals and at various meetings, but a great many companies are still inclined to experiment along this line. Such action is disastrous not only to the central station supplying service, but particularly to the power consumer who has purchased the furnace equipment. No electric furnace will give satisfactory results in a modern industrial plant unless it is supplied with electrical energy having reasonably good regulation, not greater than say 8 per cent, and it is absolutely suicidal to connect such equipment to a system which is barely staggering along with overloaded generating, transmission or distribution conditions.

Within the next few years there will undoubtedly be a more complete segregation of distribution systems in industrial centers. They will be divided into lighting circuits and entirely separate circuits to which will be connected all classes of power, including electrolytic and electrothermic loads.

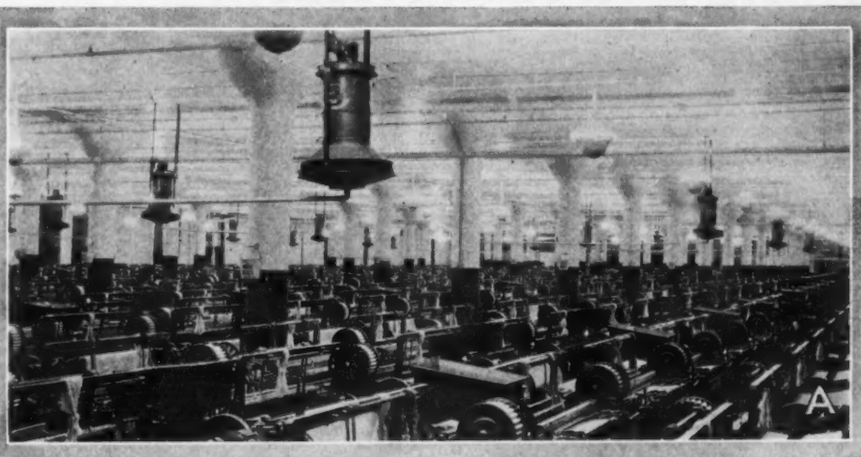
Great Opportunity in Non-Ferrous Work

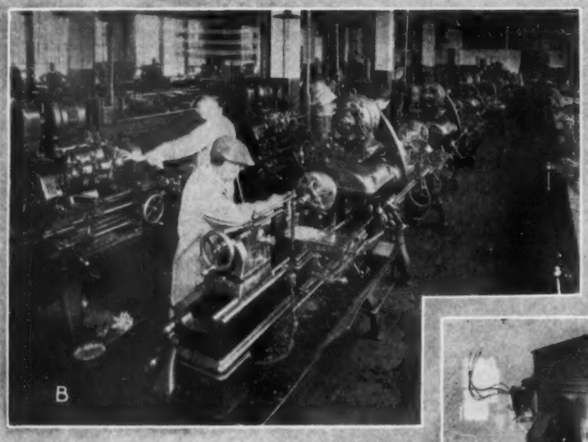
Perhaps the most remarkable development in the electric furnace industry has been in non-ferrous electric furnaces, which undoubtedly offer more advantages to the purchaser than any other kind. In addition to an output of a very much improved quality, the non-ferrous electric furnace has reduced the cost of producing this superior metal below the cost of melting where any other method is employed. Working conditions in the shops have been vastly improved because of the absence of excessive heat and fumes. Furthermore, it is now possible to teach ordinarily intelligent workmen in a comparatively short time to produce much more uniform metal with lower melting losses than could be done with fuel-fired furnaces.

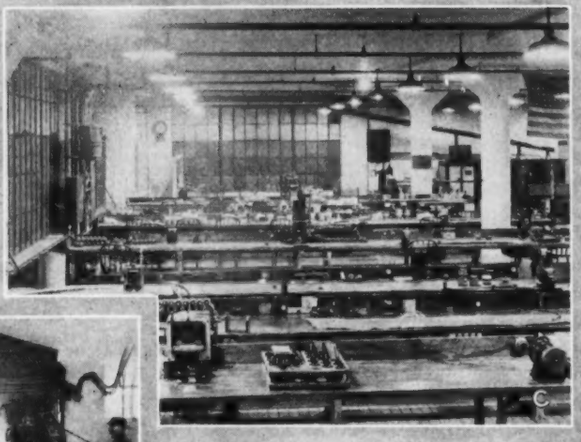
The unparalleled situation created by the war was undoubtedly the principal cause for the development of a great number of electric steel furnaces, several of which were practically identical in design, at least as far as operating practice is concerned. Continuous operation of the many furnaces installed during the time mentioned has resulted in the enforcement of the law of the survival of the fittest, and a great many furnaces which were evolved somewhat spontaneously have in general disappeared. The development in electric steel manufacture has, however, placed this product in a virtually unassailable position in the metal industry. The resumption of a healthy, normal business condition, especially in motor-car manufacture, together with the development which is certain to take place in aircraft production, will cause the business of electric steel melting to grow along a steadily increasing scale within a very few years.

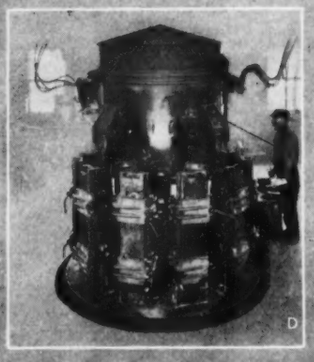
The materials necessary for the development of the electric steel furnaces up to the present point were almost without exception already at hand and in daily use in the steel industry. However, for the purposes of melting brass electrically extensive research and development have been necessary in refractories and electrodes. This work has gone along rapidly until there are today on the market furnaces which will meet prac-

Electric Light, Power and Heat Essential to Industrial Production









A—Weave room of Republic Cotton Mills, Great Falls, S. C., showing 720 looms each driven by a ½-hp. motor. Indirect-lighting units are used. This installation embodies recommendations of J. E. Sirrine & Company, mill engineers. B—A field in which the individual motor drive has revolutionized lighting and working conditions by eliminating belts and shafting. C—Modern lighting with R.L.M. reflectors in assembly room of small motor manufacturing plant. D—An electric brass furnace pouring directly into rolling-mill molds. E—Huge electric oven for baking japan on Cadillac automobile bodies. F—This illustration shows a mine pumping outfit which operates under a 1,000-ft. head. A motor of 400 hp., 1,200 r.p.m., drives a 1,000 g.p.m. six-stage centrifugal pump.

tically every requirement in the melting of non-ferrous metals. The metal industry in general seems to be fully cognizant of this fact and anticipates the universal adoption of electric melting, except possibly in the occasional instance where there is only intermittent operation—one or two small heats a day—of widely variant alloys.

Prospects for Electric Melting for Brass

While less than 5 per cent of the copper-zinc alloys produced today are melted electrically, it is confidently to be expected that within the next ten years the electric furnace will be used for melting 75 per cent of these metals.

After exhaustive investigation at least five of the largest brass melters in the world are today absolutely committed to the electric furnace for melting their entire requirements of the metals named. This decision is perhaps more easily understood when it is realized that in a great many instances the use of electric furnaces has shown a saving sufficient to amortize within ninety days or less the entire investment incident to the installation of electric melting equipment.

The continuity of operation of electric furnaces is of extreme importance to the user, and naturally to the power company supplying the service. Refractories are now developed that permit of the production of from 2,500,000 lb. to 4,000,000 lb. (1,130,000 kg. to 1,810,000 kg.) from one furnace lining. It will readily be recognized that under such conditions the cost of electric furnace maintenance is negligible as compared with that of any other combustion-type furnace.

Practically all of the brass-melting furnaces are of such construction that they must be operated single-phase, but the load required by even the largest unit is not great enough to cause serious disturbance upon the ordinarily well-balanced polyphase power system. It is only where these furnaces have been connected at the end of long, heavily loaded circuits that any difficulty due to regulation has been experienced.

In a fairly large brass foundry, heat-treating plant, rolling mill or smelting and refining plant the installation of multiple units of electric furnaces provides for a very excellent load characteristic from the standpoint of power distribution. For instance in a plant having a total connected load of from 1,500 kw. to 2,000 kw. in single-phase furnaces the load may be balanced so that at no time would the unbalance exceed 30 per cent; this would occur during the operation of one furnace. This line disturbance is slight as compared with the inherent condition in a steel furnace melting cold scrap, when the current may fluctuate instantly between open-circuit and short-circuit conditions in any phase.

The load factor in such a group installation will be comparable with the average motor-load factor in modern industrial plants, and the power factor at the primary terminals of the furnace transformers, given proper design, should in no case be less than 0.85 and can be higher.

Electric furnaces are receiving careful consideration for the production of high-quality gray-iron castings, and the development thus far indicates a very large growth in this branch of the application of electric heating. The electric melting of aluminum and also of copper for castings or wire of high tensile strength and high conductivity is rapidly becoming commercial practice.

Industrial Illumination Far Behind Lamp Development

Limits of Intensities Not Yet Reached—Safety, Production and Morale Increased by Accepting Higher Lighting Standards

By S. E. Doane

Chief Engineer National Lamp Works of the General Electric Company, Cleveland

During the past year or so the standard of industrial lighting has been steadily improved until predictions of a few years ago have become realities. It cannot be said, however, that illumination standards have kept pace with lamp development. Still, the industries are learning to look at their lighting problems in a new perspective because under these new standards of artificial lighting the quantity of industrial output has been increased and its quality has been raised. They also admit that the morale and the welfare of the worker have been bettered.

A report on engineering progress in an industrial field is usually expected to deal with developments of the products in that field and improvements that have been made in their application. However, from the standpoint of better illumination on the working plane the possibility of new and better lamps can be neglected for a time. Interest, indeed, centers more on the application of lighting units already available, since lamp application is far behind lamp development.

It is essential to remember as a collateral consideration that the improvements in the lamps and accessories themselves, together with increased generating efficiencies, have, in terms of other manufacturing costs, reduced the relative cost of light as a raw material to one-tenth of what it was ten years ago. The lamp itself, supplying light as a raw material, is only a means to an end. It only becomes effective when reduced to terms of illumination at the work. One of the greatest deterrents to progress a few years ago was the fact that under the pressure of developing a product the necessity of good light on the working plane was overlooked, with the result that industrial lighting installations oftentimes did more harm than good. So if the electric lighting industry is to make progress—progress which is fundamental—more attention must be given the application of illumination where the light begins to affect the individual.

Signs of much progress in this direction are unmistakable. During the war, when industries were making every effort to obtain capacity production, artificial lighting became an established factor of prime importance. Studies were made of the physical and psychological aspects of lighting and their relation to the individual. All of these pointed to the profitable use of higher levels of artificial illumination when properly installed and safeguarded against such evils as glare, reflected glare, etc. It is toward this end that leaders in the lighting branch of the industry are striving at the present time.

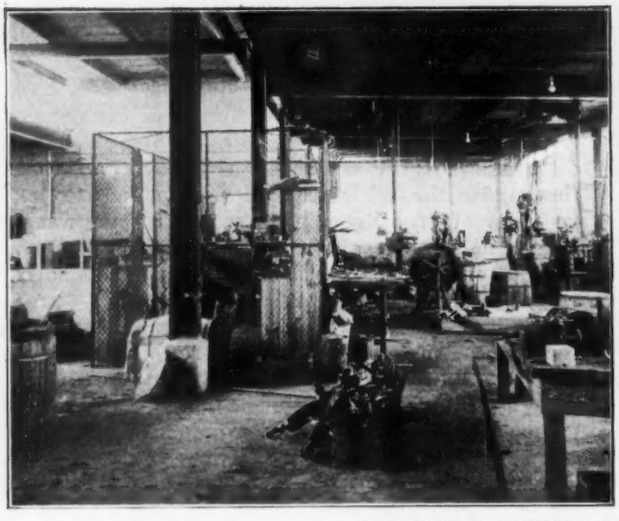
Glare, which has always been a hindrance to promotion of higher standards of lighting, has been effectively taken care of by the adoption of the bowl-enameled lamp which was brought out commercially during the past year. This lamp, used with the correct size of R.L.M. dome reflector, a product previously standardized by many manufacturers, forms a good lighting unit which is "fool proof" from the standpoint of glare. It

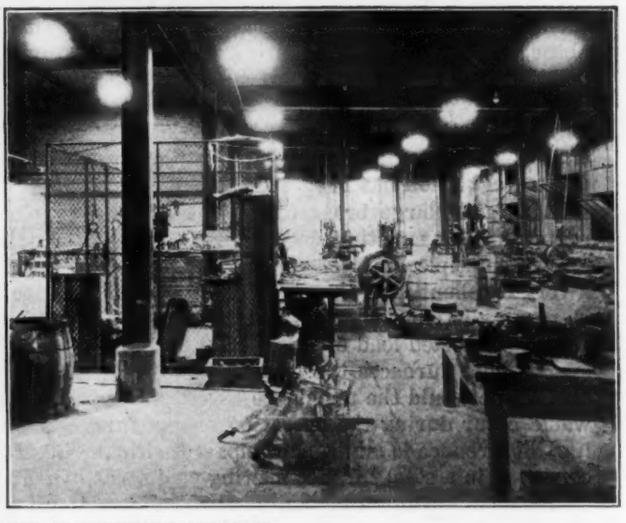
has the further advantage of being almost universally applicable to industrial lighting. Other recent lighting units of the glass-inclosed type, favorable in appearance and producing good illumination, also find limited application in the industrial lighting field. In modern practice no unit can be successful for general illumination which does not inherently eliminate glare and deliver an abundance of well-diffused light on the working plane.

A great many factory managers and foremen have a fair acquaintance with the advances made in industrial lighting and appreciate the significance of the new standards, but in a large majority of cases a practical conception of these standards is lacking. In an effort to overcome this condition the National Electric Light Association has established in the larger cities throughout the country lighting exhibitions, by means of which good lighting can be demonstrated and promoted entirely on its merits. A number of these permanent demonstrations have already been installed in places where industrial men can see what good lighting really is and

"higher intensities," is at present very problematical. A point that stands out in this connection is that the phrase "higher intensities" is not descriptive of that for which engineers are striving. In this connection it must be remembered that daylight values of illumination from a clear day out of doors may reach several thousand foot-candles. Even in the shade intensities as high as a thousand foot-candles are common and agreeable. The daylight intensities in a well-lighted factory may be several hundred foot-candles near the windows, gradually diminishing, of course, toward the centre of the room. Thus, the present artificial lighting standards, of say 5, 10 or 15 foot-candles, which are often referred to as "higher intensities," are in reality low intensities when compared with daylight conditions in the same location. The accompanying photographs may serve to illustrate this idea.

The point has not yet been reached where daylight intensities can be duplicated, but there is a marked tendency in that direction. It is difficult to foretell the limit to which the intesities of artificial illumination can be





THE SAME PLANT WITH DIFFERENT LIGHTING SYSTEMS

Top—Glaring and inadequate lighting as the result of installing lamps without shades to conceal brilliant filaments. Bottom, left—Excellent daylight illumination. Bottom, right—Efficient artificial lighting which compares favorably with daylight conditions.

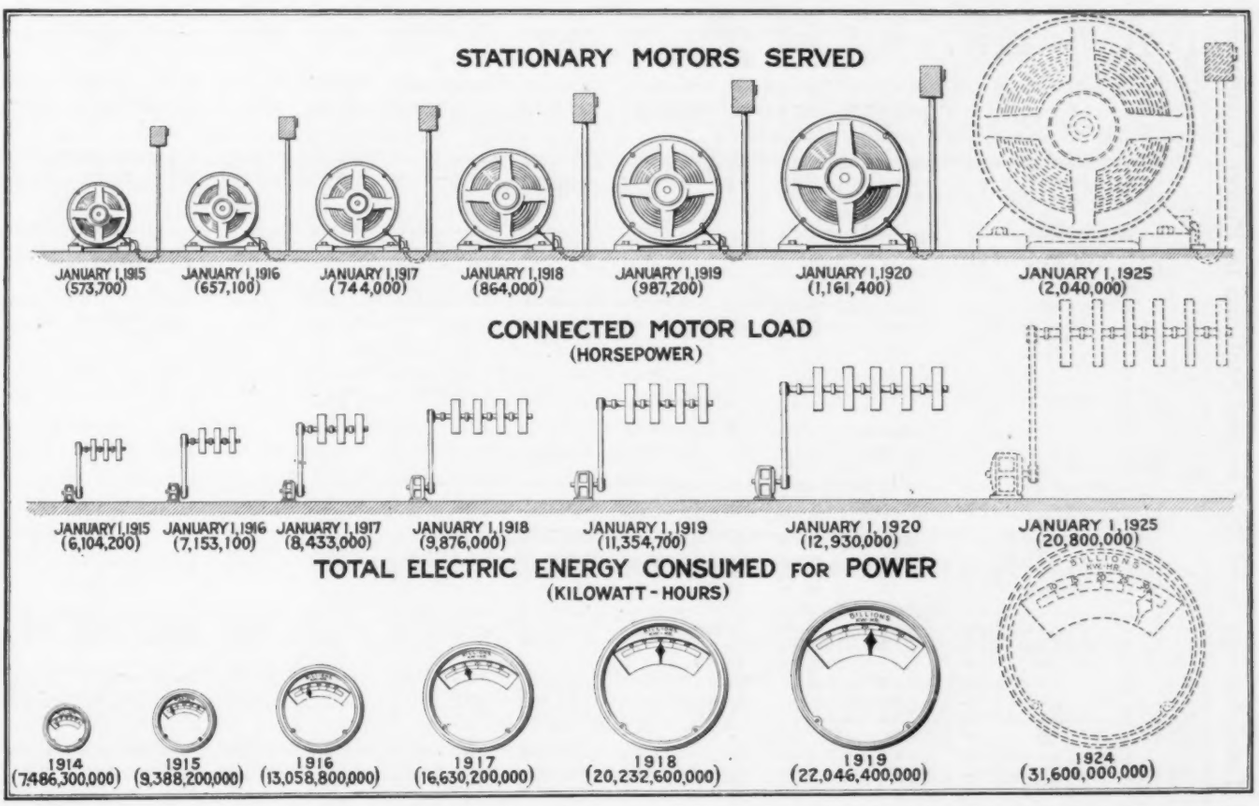
can observe its effects in contrast with old standards. This has been found to be a most effective method of bringing the industries to a proper appreciation of the advantages of productive intensity lighting. General figures are not yet available on the increased production obtained under these higher levels, but after a modern system has been installed with higher intensities there is no record of an owner, superintendent or foreman agreeing to have the illumination reduced.

It is difficult to predict just what the near future holds. Installation possibilities are enormous. What the ultimate result will be, from the standpoint of increased to advantage, but as an interesting indication of progressing thought the following is cited: A machine shop which was considered sufficiently lighted with 12 foot-candles four years ago was moved recently, and in its new location the lighting installation was designed to give 25 foot-candles. This is evidence of the change in view that has taken place in a short time.

It cannot be said positively that 25 foot-candles is too little or too much. It will take two or three years before knowledge is exact, but in that time safety will be increased and production augmented through a rule-of-thumb acceptance of higher standards.

Phenomenal Growth of Industrial Load

Nation-Wide Survey Indicates that 1,161,400 Industrial Motors Were Served by Central Stations in 1919—Motor-Connected Load Estimated at 12,930,000 Hp.—Energy Sold to Power Customers Has Increased from 7,486,300,000 Kw.-Hr. in 1914 to 22,046,400,000 Kw.-Hr. in 1919



IN AN endeavor to ascertain the growth in the use of purchased energy by industrial plants and the present status of this demand the ELECTRICAL WORLD has undertaken a comprehensive nation-wide survey of the industrial loads carried by central stations. Satisfactory replies have been received from generating and distributing companies representing about 65 per cent of the installed rating of generating stations, and from these basic data estimates have been made of the total number of motors, the connected load exclusive of lighting and the total electrical energy sold by the central stations to power customers. From the basic data received for the years 1914 to 1919 inclusive the accompanying tabulation by states and divisions of the country has been compiled. Including, as it does, the pre-war year of 1914, the war years of 1915, 1916, 1917 and 1918 and the post-war year of 1919, this tabulation presents an interesting study of the electrification of industries and gives to the executive, the electrical engineer and the electrical manufacturer a starting point from which to operate during the period of world reconstruction. A discriminating use of the table, taken in conjunction with the survey made by the ELECTRICAL WORLD to ascertain the number of wired houses in the country, which appeared in the issue of May 15, 1920, and the survey to ascertain the distribution of residential, commercial and industrial customers, which was tabulated in the issue of July 24, 1920, will enable manufacturers and jobbers of electrical supplies to measure the market of the future with confidence.

The results of this survey present some very interesting and startling statistics on central-station output and distribution growth. Monthly operation returns received by the ELECTRICAL WORLD continuously for the past six years indicate that the total output of the central stations of the United States in 1919, after deducting the energy issued in intercompany business, was 38,559,000,000 kw.-hr. The present survey indicates that the total energy sold by central stations to power customers in 1919 was 22,046,400,000 kw.-hr., or 57.2 per cent of the total output. The 1917 United States "Census of Central Stations" indicates that about 14.4 per cent of the total output is dissipated in distribution and line losses, the loss from these sources in 1919 being about 5,555,000,000 kw.-hr. The total output sold to lighting customers in 1919 was, therefore, about 10,957,600,000 kw.-hr., or 28.4 per cent of the total output. In 1915 the energy sold to power customers was about 51.1 per cent of the total output, and lighting customers consumed about 34.5 per cent, indicating that from 1915 to 1920 the proportion of the total output sold for power increased by about 6.1 per cent.

Number of Motors Served, Connected Load and Total Energy Sold By Central Stations to Power Customers—1914 to 1920

Division and State	Industrial Motors Served* (Thousands)						Motor Connected Load* (Thousands of Horsepower)						Other Connected Load (Not Lighting)* (Thousands of Horsepower)						Total Electrical Energy Sold to Power Customers (Millions of Kilowatt-Hours)					
	1915	1916	1917	1918	1919	1920	1915	1916	1917	1918	1919	1920	1915	1916	1917	1918	1919	1920	1914	1915	1916	1917	1918	1919
United States	573.7	657.1	744.0	864.0	987.2	1,161.4	6,104.2	7,153.1	8,433.0	9,876.0	11,354.7	12,930.0	684.0	839.6	1,058.8	1,446.8	1,679.0	1,868.8	7,486.3	9,388.2	13,058.8	16,630.2	20,232.6	22,046.4
SECTIONS:																								
New England	79.8	91.0	102.4	120.4	137.4	169.2	742.1	830.0	983.3	1,181.0	1,356.8	1,640.6	20.2	23.7	27.2	46.3	51.1	56.3	608.7	733.9	1,063.1	1,339.0	1,681.9	1,856.0
Middle Atlantic	134.1	158.2	183.6	222.7	268.8	322.1	1,372.7	1,717.7	2,081.4	2,541.2	3,130.3	3,547.0	262.5	301.1	341.3	531.9	571.4	606.6	2,303.7	2,846.8	3,975.5	5,435.2	6,823.5	6,740.5
South Atlantic	20.9	23.4	26.3	32.3	39.1	47.5	278.6	326.3	395.1	507.5	640.4	803.5	36.6	24.1	51.9	60.8	78.1	105.2	453.9	585.3	687.0	952.1	1,197.9	1,622.9
East North Central	130.1	152.4	178.9	212.0	233.7	275.9	1,345.4	1,559.2	1,825.9	2,203.5	2,555.8	2,653.4	134.6	172.6	217.9	272.6	312.9	360.0	1,223.5	1,660.1	2,498.8	3,308.0	3,898.7	4,479.8
West North Central	53.3	58.1	63.5	72.3	80.0	93.0	476.9	561.8	664.9	757.1	832.2	940.8	16.4	18.0	22.3	40.5	67.1	73.0	673.5	855.8	1,061.3	1,207.9	1,298.7	1,533.5
East South Central	22.8	24.9	27.2	29.1	32.6	37.3	100.7	128.9	167.2	209.3	263.0	304.1	15.1	18.6	22.2	27.0	72.0	117.2	99.4	151.5	251.6	349.6	465.2	654.0
West South Central	17.5	20.0	23.8	27.7	31.8	36.2	134.3	165.0	209.0	273.5	329.4	479.5	7.6	7.9	16.1	18.9	24.2	28.1	91.6	125.3	188.4	284.4	453.3	564.0
Mountain	26.3	29.4	32.1	38.1	41.6	46.0	415.7	513.5	574.6	645.3	670.3	732.6	97.7	179.8	260.5	311.6	347.3	345.3	715.5	1,043.9	1,776.9	1,889.2	2,067.2	1,872.9
Pacific	88.9	99.7	106.2	109.4	122.2	134.2	1,237.7	1,350.7	1,531.6	1,557.6	1,576.5	1,828.5	93.3	93.8	98.8	137.2	154.8	177.1	1,316.5	1,385.6	1,556.2	1,864.8	2,346.2	2,722.8
NEW ENGLAND:																								
Maine	3.7	3.8	3.6	3.9	4.2	4.6	46.2	47.6	49.1	57.0	60.3	65.4	0.8	1.7	1.7	1.7	1.8	1.8	100.5	112.6	126.2	133.1	211.5	193.7
New Hampshire	2.6	2.8	3.2	3.7	4.0	4.3	28.8	30.7	34.1	41.4	47.7	55.5	0.3	0.7	0.7	0.7	0.8	0.8	28.2	35.6	44.3	64.8	81.3	94.8
Vermont	3.3	3.3	3.5	3.8	3.9	4.2	31.7	36.5	39.4	43.5	43.7	47.7	2.3	2.3	3.0	3.0	3.3	3.3	60.8	60.0	81.6	95.3	129.0	148.2
Massachusetts	43.8	53.4	63.0	77.3	92.3	110.8	431.0	488.0	608.0	750.0	882.0	1,063.0	15.9	18.1	20.7	39.7	42.3	46.1	300.0	375.3	557.5	707.0	858.0	978.0
Rhode Island	3.8	4.1	4.6	5.3	5.6	6.3	51.0	56.2	62.2	72.1	81.1	108.0	0.2	0.2	0.2	0.2	0.5	0.8	44.8	59.7	92.6	122.7	146.0	161.0
Connecticut	22.6	23.6	24.5	26.4	27.4	39.0	153.4	171.0	190.5	217.0	242.0	301.0	0.7	0.7	0.9	1.0	2.4	3.5	74.4	90.7	160.9	216.1	256.1	280.3
MIDDLE ATLANTIC:																								
New York	79.3	92.8	103.0	115.3	137.5	151.8	718.0	867.0	978.0	1,103.0	1,265.0	1,400.0	134.0	162.6	184.2	360.2	383.8	363.0	1,218.0	1,542.0	2,035.0	2,672.7	3,620.0	3,475.0
New Jersey	15.4	19.4	24.6	30.9	40.5	42.5	139.7	180.7	233.4	298.2	372.3	397.0	22.9	24.0	32.8	35.5	42.8	46.8	79.7	122.8	205.5	299.0	383.5	360.5
Pennsylvania	39.4	46.0	56.0	76.5	90.8	127.8	515.0	670.0	8.0.0	1,140.(	1,493.0	1,750.0	105.6	114.5	124.3	136.2	144.8	196.8	1,006.0	1,182.0	1,735.0	2,463.5	2,820.0	2,905.0
SOUTH ATLANTIC:																								
Delaware	0.7	0.8	0.9	1.1	1.2	1.4	7.2	8.1	15.4	24.2	36.7	38.8	0.1	0.1	0.2	0.2	0.3	0.3	3.8	5.3	10.6	22.6	33.0	38.0
Maryland	4.8	5.6	6.4	10.3	14.1	18.7	62.8	71.0	80.2	130.5	180.0	239.5	6.0	9.2	14.0	18.8	32.2	40.6	102.6	120.2	140.8	223.5	318.5	418.0
Dist. of Columbia	0.6	0.7	0.8	1.0	1.1	1.3	16.1	20.3	23.4	25.7	29.4	35.0	5.1	5.1	5.2	5.7	7.0	8.7	7.2	9.0	11.5	17.8	23.4	32.5
Virginia	1.0	1.5	1.9	2.2	2.5	3.1	10.5	14.9	21.1	27.8	38.5	41.9	1.1	1.6	1.7	2.0	2.1	3.5	37.2	53.9	60.1	115.2	173.0	205.7
West Virginia	2.9	3.1	3.5	3.9	5.6	6.2	53.5	67.7	85.6	98.6	109.2	136.4	19.7	21.4	23.3	25.6	27.2	36.9	55.4	75.0	102.2	140.0	153.4	242.0
North Carolina	3.8	4.1	4.6	5.0	5.2	5.9	37.8	41.3	50.7	59.5	75.7	91.5	1.2	1.8	2.0	2.3	2.5	4.1	86.3	107.0	124.0	146.2	158.0	235.0
South Carolina	2.1	2.2	2.4	2.5	2.6	2.9	24.7	27.9	32.0	37.5	43.8	52.2	1.4	2.1	2.3	2.6	2.9	4.7	63.8	79.5	92.2	108.2	117.0	174.0
Georgia	3.4	3.7	4.0	4.2	4.4	4.8	53.8	60.7	69.7	81.5	95.1	113.5	1.6	2.3	2.6	2.9	3.2	5.2	88.5	124.0	127.0	157.7	179.8	206.9
Florida	1.6	1.7	1.8	2.1	2.4	3.2	12.2	14.4	17.0	22.2	32.0	54.7	0.4	0.5	0.6	0.7	0.7	1.2	9.1	11.4	18.6	20.9	41.8	70.8
EAST NO. CENTRAL:																								
Ohio	26.1	29.1	32.4	36.0	37.8	42.0	160.5	178.0	198.0	265.3	317.0	391.0	42.5	53.5	67.3	90.7	90.3	97.3	142.0	252.0	448.0	603.5	662.5	720.0
Indiana	8.7	9.6	10.7	14.3	22.6	31.7	107.2	117.3	128.4	139.7	158.0	180.4	14.2	18.0	22.8	28.8	34.7	38.8	114.5	143.2	181.8	245.7	290.2	311.3
Illinois	61.2	71.4	83.5	100.4	108.0	125.3	665.0	792.5	910.0	1,079.0	1,200.0	1,305.0	32.6	45.3	56.8	74.7	91.4	118.1	502.0	637.0	812.0	1,058.9	1,312.0	1,590.0
Michigan	26.4	33.8	43.3	50.3	53.3	63.6	288.0	331.0	422.5	502.5	562.0	647.0	29.8	31.2	42.8	46.4	55.8	61.0	345.0	442.5	802.0	1 058.6	1,255.0	1,470.0
Wisconsin	7.7	8.5	9.0	11.0	12.0	13.3	124.8	140.4	167.0	217.0	318.8	330.0	15.5	24.6	28.2	32.0	40.7	44.8	120.0	183.4	255.0	341.3	379.0	388.5
WEST NO. CENTRAL:																								
Minnesota	16.7	17.0	17.4	20.9	21.2	25.3	211.2	231.0	252.0	282.8	298.0	322.0	0.1	0.1	0.9	1.1	3.0	3.1	277.5	380.5	446.6	518.2	474.3	568.0
Iowa	11.2	12.6	14.1	15.7	16.6	17.5	65.2	72.5	80.7	89.9	95.3	104.0	0.1	0.2	1.2	1.5	3.9	4.0	93.2	107.9	131.2	159.5	191.4	256.1
Missouri	9.5	10.5	12.4	13.7	15.4	17.2	115.6	128.2	155.8	174.9	202.1	234.8	14.8	16.2	17.7	28.0	42.1	46.4	157.7	201.7	289.0	303.4	354.7	397.4
North Dakota	1.6	1.8	1.9	2.3	2.5	3.1	8.9	9.5	9.9	11.1	11.9	12.9	0.1	0.1	0.1	0.7	1.1	1.2	4.7	5.1	5.3	5.9	6.3	6.9
South Dakota	2.3	2.6	2.6	3.1	3.5	4.3	15.8	16.9	17.6	19.7	21.2	22.9	0.1	0.1	0.3	1.7	2.2	2.2	12.6	13.2	12.3	11.0	10.5	12.8
Nebraska	6.0	6.8	7.5	7.8	10.7	14.4	24.8	28.3	49.1	57.4	74.5	100.2	0.2	0.2	0.3	2.4	4.9	5.3	38.0	40.4	51.4	61.9	90.3	117.8
Kansas	6.0	6.8	7.6	8.8	10.1	11.2	35.4	75.4	99.8	121.3	129.2	144.0	1.0	1.1	1.8	5.1	9.9	10.8	89.8	107.0	125.5	148.0	171.2	174.5
EAST SO. CENTRAL:																								
Kentucky	6.8	7.6	8.5	9.2	12.0	14.7	19.0	30.9	50.5	63.8	77.2	99.2	0.7	1.1	1.2	1.3	1.9	2.0	16.7	26.0	41.1	69.9	69.9	103.1
Tennessee	3.0	3.2	3.5	3.7	3.8	4.1	32.0	35.6	39.8	43.2	44.8	54.5	1.1	1.6	1.8	2.1	2.8	3.1	45.9	58.6	75.1	89.5	105.2	173.2
Alabama	12.0	13.0	14.1	15.0	15.5	17.2	40.8	51.3	64.5	88.5	126.7	133.4	10.5	13.1	16.4	20.8	64.5	109.3	20.5	48.2	113.9	171.4	271.0	356.2
Mississippi	1.0	1.1	1.1	1.2	1.3	1.3	8.9	11.1	12.4	13.8	14.3	17.0	2.8	2.8	2.8	2.8	2.8	2.8	16.3	18.7	21.5	18.8	19.1	21.5
WEST SO. CENTRAL:																								
Arkansas	0.9	1.0	1.1	1.2	1.3	1.4	7.9	8.9	10.1	11.5	12.7	15.9	1.9	2.0	3.1	3.6	3.6	3.7	7.8	10.8	13.6	19.0	21.5	23.4
Louisiana	0.7	0.8	3.0	3.2	3.7	4.5	15.8	20.8	30.8	37.2	44.3	68.3	1.4	1.4	2.7	3.4	3.9	5.8	10.9	12.5	22.5	28.5	43.3	53.6
Oklahoma	4.0	4.6	5.2	6.4	7.3	8.8	31.1	36.8	45.6	61.3	70.2	94.8	2.8	2.9	4.6	5.2	9.2	10.6	18.1	22.8	37.8	66.1	84.5	96.0
Texas	11.9	13.6	14.5	16.9	19.5	21.5	79.5	98.5	122.5	163.5	202.2	300.5	1.5	1.6	5.7	6.7	7.5	8.0	54.8	79.2	114.5	170.8	304.0	391.0
MOUNTAIN:																								
Montana	7.3	9.4	11.2	13.0	13.6	14.5	162.3	204.5	211.5	231.5	237.5	256.0	32.0	81.7	138.0	173.0	198.5	200.0	282.5	508.0	915.0	1,012,0	1,195.0	898.0
Idaho	2.3	2.4	2.4	3.0	3.5	4.1	10.1	23.2	34.8	43.8	47.4	59.2	8.2	18.5	31.2	39.2	44.8	45.0	53.5	96.5	175.2	194.6	235.8	258.6
Wyoming	0.4	0.4	0.4	0.8	0.9	1.0	15.8	16.3	15.8	15.0	22.8	23.7	0.1	0.2	0.6	1.0	1.1	1.2	7.5	8.2	9.1	13.7	14.9	15.7
Colorado	7.4	7.7	8.1	8.8	9.7	10.2	78.8	100.8	129.3	155.6	157.4	158.5	0.1	0.1	0.1	4.1	8.5	8.9	117.6	133.6	152.1	176.2	196.2	188.6
New Mexico	0.3	0.5	0.6	0.7	0.7	0.8	5.3	5.6	5.9	6.2	6.2	6.1	0.1	0.2	0.3	0.4	0.5	0.5	4.5	6.6	6.2	7.0	7.5	7.6
Arizona	0.8	1.0	1.1	1.4	1.4	1.6	14.5	15.0	15.9	16.5	16.6	16.4	45.2	61.1	64.3	66.9	66.9	65.7	25.7	30.2	92.7	54.0	44.4	90.0
Utah	7.2	7.3	7.5	9.4	10.8	12.6	115.0	133.7	146.2	160.8	166.5	197.0	....	....	4.0	4.0	4.0	4.0	207.2	240.8	365.2	396.0	344.0	355.0
Nevada	0.6	0.7	0.8	1.0	1.0	1.2	13.9	14.4	15.2	15.9	15.9	15.7	12.0	18.0	22.0	23.0	23.0	20.0	17.0	20.0	61.4	35.7	29.4	59.4
PACIFIC:																								
Washington	3.4	3.5	4.3	5.7	9.2	10.2	63.7	65.3	71.0	86.0	103.0	114.0	3.8	4.0	5.7	9.1	24.6	39.8	89.2	92.4	119.0	147.7	333.0	509.0
Oregon	1.7	2.9	5.2	6.4	7.2	7.5	22.0	38.4	49.6	61.3	69.5	72.5	0.2	0.3	0.5	1.5	2.6	7.7	52.7	59.7	67.2	88.6	110.7	118.8
California	83.8	93.3	96.7	97.3	105.8	116.5	1,152.0	1,247.0	1,411.0	1,410.3	1,404.0	1,642.0	89.3	89.5	92.6	126.6	127.6	129.6	1,174.6	1,233.5	1,370.0	1,628.5	1,902.5	2,095.0

*January 1 of each year

The growth in number of motors served, motor-connected load and the energy sold by central stations to power customers during the five-year period from 1915 to 1920 is shown diagrammatically by the accompanying curves. These curves have been projected five years into the future, giving some idea of probable central-station operations in 1925.

In 1919 there were 1,161,400 industrial motors served by central stations. The Atlantic States, comprising New York, New Jersey and Pennsylvania, lead all other sections of the country in number of industrial motors served, with 322,100, being followed at some distance by another essentially industrial section, the East North Central States, with 275,900 motors. Of the 134,200 motors attributed to the Pacific States in 1919 more than 87 per cent were in California. The greatest proportionate growth in number of motors during the five-year period was shown in the Middle Atlantic States, with 140 per cent. Pennsylvania leads the states in number of motors served, being followed by New York and Illinois in order. The total number of installed motors which will be served by central stations in 1925 is estimated at 2,040,000.

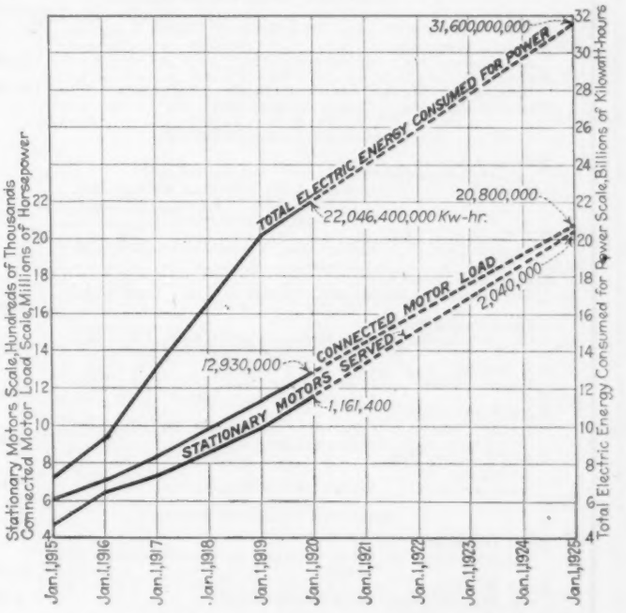
A study of the returns received by the ELECTRICAL WORLD indicates that the increase both in number and horsepower of motors has been, during the five-year period, much more rapid for the municipal than for the commercial plants. Prior to 1907 the municipal stations did virtually no power business, and even in 1919 they returned only a relatively small proportion of the total connected horsepower for all central stations, about 5 per cent. This explains this relatively large percentage increase. On the other hand, the returns show that the municipal plants serve about 10 per cent of the stationary motors, which would indicate that the average horsepower of motors served by municipal plants is much smaller than that for the commercial plants.

The remarkable growth in the use of electrical energy in the mills and factories of the country is best shown by the tabulation of the motor-connected load. The total motor-connected load of the central stations on Jan. 1, 1920, is estimated at 12,930,000 hp. It is interesting to note that during the period from 1907 to 1920 the rate of increase in horsepower of motors for the various sections of the country has been relatively uniform. The divisions of the country follow the same relative rank as in the motor tabulation, the Middle Atlantic section leading with 3,547,000 hp. and the East North Central States following with 2,653,400 hp. Although New York State leads in the number of industrial motors served, yet a large proportion of the motors are evidently of small rating, as the Empire State is led in motor-connected load by both Pennsylvania, with 1,750,000 hp., and California, with 1,642,000 hp. By projection of the motor-connected load curve the figure of 20,800,000 hp. is obtained for Jan. 1, 1925.

Under "other connected load, not lighting," are included central-station electric railway load, electric furnace load, etc. The total power load of this class is estimated at 1,868,800 hp., New York State leading with 363,000 hp., followed by Montana with 200,000 hp.

The per capita consumption of electrical energy for power purposes during 1919 in all districts within reach of central-station service was about 355 kw.-hr., as against a per capita consumption of 176 kw.-hr. for lighting. The highest per capita consumption of electrical energy for power is found in the Mountain section, which reports 913 kw.-hr., a figure almost twice as high as that shown by the Pacific division, with 580 kw.-hr. In the Mountain section, with the exception of Wyoming and New Mexico, the per capita consumption is higher than in most states. This would seem to be accounted for by the enormous quantity of electrical energy used in mining operations in the Mountain States and the large agricultural pumping load in Idaho. California, where more extensive hydro-electric developments are found than in any other state, ranks among the highest in the per capita consumption of electrical energy for industrial power, with 742 kw.-hr. None of the so-called "industrial" states appears to have a per capita power consumption at all approaching that of the Mountain and Pacific States.

The industrial consumption of electrical energy during 1919 is especially significant of the stability of the



THE RAPID GROWTH IN THE ADOPTION OF ELECTRICAL ENERGY AS A SOURCE OF INDUSTRIAL MOTIVE POWER

central-station industry. In spite of large curtailment of war-time industrial activity throughout the country during the year, the returns of the survey indicate that only the Middle Atlantic and Mountain States decreased their industrial energy consumption. All other sections of the country increased their consumption over 1918, the South Atlantic States making larger gains in 1919 than even during the war years. The decreases and increases are in all cases due to local economic reasons, especially in the Mountain States, where the stagnation in copper mining was especially noticeable. The estimate of 31,600,000,000 kw.-hr. as the probable total amount of electrical energy to be sold to power customers in 1924 is believed to be very conservative, as it is based largely on the amount of energy sold for similar purposes during 1919.

The results of the investigation show that during the war period the central station made phenomenal strides as a source of energy for American industry. An increase in energy sold for power consumption of from 7,500,000,000 kw.-hr. in 1914 to 22,000,000,000 kw.-hr. in 1919 is an achievement worthy of the men who have given the central-station industry the kind of management and thought which makes for success.

Water-Power Applications Total Over 10,000,000 Horsepower

Federal Power Commission Reports 129 Applications for Preliminary Power Permits Filed Prior to Dec. 18— Total Horsepower Involved Exceeds Present Total Water-Power Developments of the Country— New York State Leads the Union in Total Horsepower of Proposed Developments.

WATER-POWER applications now on file with the Federal Power Commission involve a development of over 10,000,000 hp. This is in excess of the total water-power developments on Jan. 1, 1920, as estimated by the ELECTRICAL WORLD in its water-power issue of March 20, 1920. Following is a list of the applications on file with the commission prior to Nov. 20. These applications total 7,726,651 hp., but if the treaty with Canada relative to the diversion of the water of the Niagara River is modified to permit the diversion of 20,000 second-feet in addition to the amount allowed under the regulations of the present treaty, these figures will be increased by 400,000 hp., giving a total to Nov. 20 of 8,126,651 hp. New York State leads in total horsepower involved with 2,933,250 hp., followed by California with 1,071,123 hp. and Washington with 1,066,000 hp. Complete details on applications filed since Nov. 20 are not available at the present time.

ALABAMA (Total 150,000 Hp.)

Name of Company	Location of Project	Capacity, Hp.
Alabama Power Co., Birmingham, Ala.	Coosa River, Ala.	30,000
Alabama Power Co., Birmingham, Ala.	Coosa River, Duncan's Riffle, Ala.	120,000
City of Dothan, Ala.	Choctawhatchee River, Ala.	.....

ALASKA (Total 58,300 Hp.)

Alaskan-American Paper Corp., New York City	Orchard Lake outlet to Shrimp Bay, Revillagigedo Island, Tongass National Forest, Alaska	7,000
R. L. Weeks, Los Angeles, Cal.	Shrimp Bay, Tongass National Forest, Alaska	7,000
Speel River Project, San Francisco, Cal.	Speel River, Crater Lake, Long Lake, Alaska	10,000
Tongass Pulp & Paper Co., Seattle, Wash.	Fish Creek, Swan Creek, Big Lake, Mirror Lake, Swan Lake, Alaska	19,000
L. J. Vogter, Tacoma, Wash.	Orchard Lake, Swan Lake, Fish Creek, Shelockum Lake, Alaska	32,000
William D. Grantet al, Wrangel, Alaska	Critterden Creek, Mill Co., Bradfield River, Alaska	16,000
Alaska Endicott Mng. & Milling Co., Juneau, Alaska	William Henry Bay, Alaska	300

ARIZONA (Total 589,200 Hp.)

Frank G. Baum, San Francisco, Cal.	Little Colorado River at Grand Falls, Ariz.	27,900
Frank G. Baum, San Francisco, Cal.	Black River, Arizona	6,300
Beckman & Linden Engineering Corpn., San Francisco, Cal.	Colorado River, Ariz.	126,000
C. A. Heberlein, Prescott, Ariz.	Cataract Creek, Grand Canyon National Park, Ariz.	9,000
Edward L. Bayard, Seligman, Ariz.	Hualpai Indian Reservation, Colorado River, Ariz.	420,000

ARKANSAS (Total 125,000 Hp.)

Garland Hydro Electric Power Co., Little Rock, Ark.	Ovachita River near boundary between Montgomery and Garland Counties, Ark.	25,000
Dixie Power Co., St. Louis, Mo.	White River, Ark.	100,000

CALIFORNIA (Total 1,071,123 Hp.)

Coast Valleys Gas & Electric Co., San Francisco, Calif.	San Benito, Cal., Transmission Line	.....
City of Los Angeles.	South and Middle Forks and Kings River, Cal.	400,000
Merced Irrigation Dist., Merced, Cal.	Exchequer on Merced River, Cal.	40,000
The Nevada-California Power Co., San Francisco, Cal.	Warren Creek & Slate Creek, Leevining Creek, Bishop Creek, Cal.	19,000
Emma Rose et al San Francisco, Cal.	Stanislaus River, Cal.	30,000
San Joaquin Light & Power Corpn., Fresno, Cal.	San Joaquin River, Cal.	45,000
Southern California Edison Co., Los Angeles, Cal.	Salmon Creek, Cal.	7,500
Western States Gas & Electric Co., Stockton, Cal.	Trinity National Forest, Cal.	2,500
Pitt River Power Co., Washington, D. C.	Pitt River, Cal.	92,000

CALIFORNIA (Continued)

R. W. Hawley, San Francisco, Cal.	Silver Creek, Cal.	107,000
Luther Hill, Independence, Cal.	Sam Mill Creek, Cal.	386
A. P. Seybold, San Francisco, Cal.	Klamath River and Bluff Creek, Cal.	31,200
Sespe Light & Power Co., Los Angeles, Cal.	Piru Creek, Cal.	15,000
Southern California Edison Co., Los Angeles, Cal.	Big Creek, Cal.	120,000
H. H. Wadsworth, San Francisco, Cal.	Middle Yuba, near Dobbins Creek, Cal.	30,000
Southern Sierras Power Co., Riverside, Cal.	Convict Creek, Cal.	6,800
J. G. Van Zandt, San Francisco, Cal.	Bear Creek, Santa Ana Creek, Cal.	37,000
R. G. McDonald, Williams, Cal.	Convict Creek, Cal.	4,000
J. Harvey Pierce, Los Angeles, Cal.	Mammoth Creek, Cal.	737
Snow Mountain Water & Power Co., San Francisco, Cal.	Not given	15,000
Western States Gas & Electric Co., Stockton, Cal.	South Fork, American River, Cal.	72,000

FLORIDA (Total 8,600 Hp.)

The Cove Co., Ocala, Fla.	Withtacoochee River, Fla.	4,000
Reed Bingham, Pensacola, Fla.	Perdido, Styx and Blackwater Rivers, Ala. and Fla.	4,600

IDAHO (Total 260,500 Hp.)

G. W. Sperry, Bonners Ferry, Ida.	Moyie River, Idaho	5,000
Idaho Power Co., Washington, D. C.	Snake River (Twin Falls), Idaho	25,000
Idaho Power Co., Washington, D. C.	Snake River (Upper Salmon Falls), Ida.	66,000
Utah Power & Light Co., Washington, D. C.	Bear River, Idaho	21,500
Moore's Creek Boulder Gold Dredging Co., Boise, Idaho	Transmission Line	.....
Electro-Metals Co., San Francisco, Cal.	Salmon River, Idaho	143,000

ILLINOIS (Total 40,000 Hp.)

State of Illinois, Springfield, Ill.	Desplaines and Illinois Rivers, Illinois	40,000

MASSACHUSETTS (Total 20,000 Hp.)

A. P. Connor, Springfield, Mass.	Connecticut River, Conn. and Mass.	20,000

MINNESOTA (Total 17,000 Hp.)

J. D. Markham, et al, St. Paul, Minn.	St. Croix River, Minn.	11,000
St. Cloud Electric Power Co., St. Cloud, Minn.	Mississippi River, Minn.	6,000
Grand Rapids.	Mississippi River, Minn.	.....

MISSISSIPPI (Total 1,500 Hp.)

W. H. Shrader, Pensacola, Fla.	Sunflower River, Miss.	1,500

MISSOURI (Total 32,000 Hp.)

John Daniell, Springfield, Mo.	Current River, Mo.	30,000
Western Tie & Timber Co., St. Louis, Mo.	Current River, Mo.	4,000
W. R. Banks, Lamar, Mo.	Osage and Nianqua Rivers, Mo.	2,000

MONTANA (Total 490,778 Hp.)

Name of Company	Location of Project	Capacity, Hp.
Amazon Dixie Mining Co., Wallace, Idaho	Lolo National Forest, Mont., Transmission Line	.....
Town of Ronan, Mont.	Crow Creek, Mont	200
Rocky Mountain Power Co., New York City	Flathead Lake and River, Mont	272,000
Big Horn Canyon Irrigation and Pwr. Co., Hardin, Mont.	Big Horn River, Mont	217,550
Montana Water, Power & Electric Co., Portland, Ore.	South Fork Flathead River, Mont	.....
William Park Mills, Missoula, Mont.	Vermilion River, Mont	600
Rock Creek Power Co. Missoula, Mont.	Rock Creek, Mont	428

NEW JERSEY (Total 432,300 Hp.)

Paul T. Brady, New York City	Delaware River, N. Y., Pa., and N. J.	228,600
Canada Syndicate, Ltd., New York City	Delaware River, N. Y., Pa. and N. J.	432,300
W. C. Elbertson et al., Newark, N. J.	Delaware River, Foul Rift, N. J.	20,000

NEW YORK (Total 2,933,250 Hp.)

Niagara County Irrigation & Water Supply Co., Washington, D. C.	Niagara River, N. Y.	75,000
St. Lawrence Trans. Co., Potsdam, N. Y.	St. Lawrence River, N. Y.	900,000
Ford Motor Co., Dearborn, Mich.	Green Island, Hudson River, N. Y.	8,250
Western New York Utilities Co., Inc., Medina, N. Y.	Erie Canal, N. Y.	10,000
Hydraulic Race Co., Lockport, N. Y.	Niagara River, N. Y.	5,000
Niagara Falls Power Co., Niagara Falls, N. Y.	Niagara River, N. Y.	(a) 400,000
Louisville Power Corpn., New York City	St. Lawrence River, N. Y.	600,000
Lower Niagara River Power & Water Supply Co., New York City	Niagara River, N. Y.	250,000
Niagara, Lockport & Ontario Power Co., Buffalo, N. Y.	Niagara River, N. Y.	(b)
City of Buffalo	Niagara River, N. Y.	.....
J. K. Thomson et al., Buffalo, N. Y.	Niagara River, N. Y.	900,000
M. F. Bowen, Washington, D. C.	Lake Erie, Niagara River, N. Y.	800,000
Niagara Gorge Power Co., Buffalo, N. Y.	Niagara River, N. Y.	300,000

NORTH CAROLINA (Total 3,400 Hp.)

Granite Falls Mfg. Co. Granite Falls, N. C.	Wilson Creek, N. C.	2,000
United Mills Co., Hickory, N. C.	Harpers Creek, N. C.	1,400

OKLAHOMA (Total 4,500 Hp.)

Courtland P. Chenault, Tulsa, Okla.	Arkansas River, Okla.	3,000
W. T. Larimore, et al, Hugo, Okla.	Little River, Okla.	1,500

OREGON (Total 385,200 Hp.)

Name of Company	Location of Project	Capacity, Hp.
Crown Willamette Paper Co., Portland, Ore.	Willamette River, Ore.	7,200
Columbia Valley Pwr. Co., New York City	Deschutes River, Ore.	378,000

PENNSYLVANIA (Total 20,000 Hp.)

W. A. Dromgold, York, Pa.	Susquehanna River, Pa.	20,000

SOUTH DAKOTA

Paving Granite Quarry Co., Rapid City, S. D.	Blackhills Nat. Forest, S. D., Transmission Line.	

VIRGINIA (Total 98,000 Hp.)

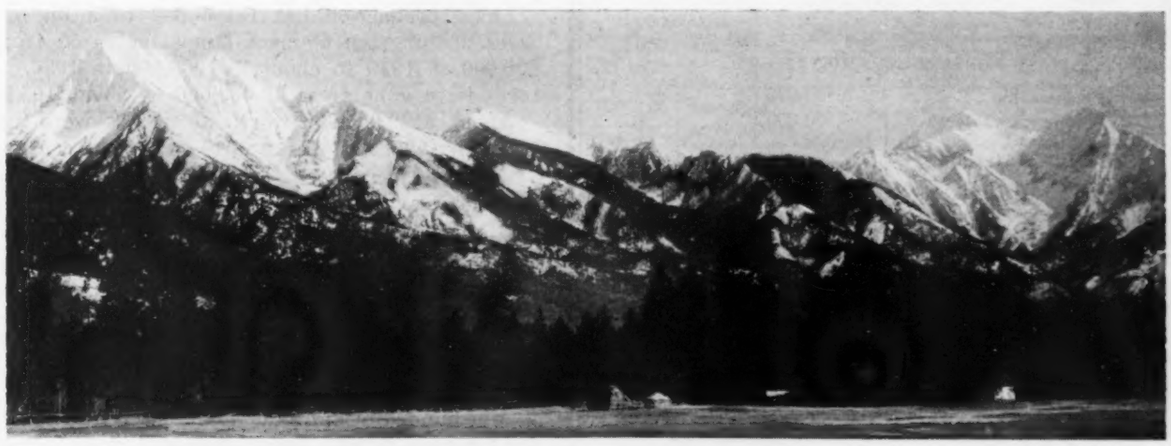
Roanoke River Development Co., Richmond, Va.	Roanoke, Va.	60,000
Big Bend Power Co., Lynchburg, Va.	James River, Va.	8,000
Tri-State Power & Milling Co., Salem, Va.	New River, Va., and W. Va.	30,000

WASHINGTON (Total 1,066,000 Hp.)

Washington Irrigation & Development Co., New York City	Columbia River, Washington	300,000
Sound Power Co., New York City	Sultan River & Olney Creek, Wash.	106,000
Straits Power Co., New York City	Soldue River and Crescent Lake, Wash.	95,000
Northwestern Power & Manufacturing Co., Seattle, Wash.	Lake Crescent, Lyre River, Wash.	5,000
Alex Polson, et al, Montesano, Wash.	Wyanooche River, Wash.	
Hugh L. Cooper, New York City	Columbia River, Wash.	350,000
Washington Development Corporation, Seattle, Wash.	Dungeness River and West Fork Creek, Wash.	
Spirit Lake Railway & Power Co., Vancouver, Wash.	Spirit Lake, Wash.	10,000
William F. Scheffel, Wenatchee, Wash.	Columbia River, Wash.	100,000
Wenatchee Commercial Club, Wenatchee, Wash.	Rock Island and Cabinet Rapids, Columbia River, Wash.	100,000

Total horsepower involved in applications	**9,411,251** (a)
Conflicts with other applications	**1,684,600** (b)
Net total horsepower	**7,726,651** (a

(a) If treaty is modified figures will be increased by 400,000 hp.
(b) If treaty is modified figures will be increased by 550,000 hp.



HIGH SNOW-COVERED PEAKS IN MONTANA FROM WHICH THE MONTANA POWER COMPANY DRAWS ITS "WHITE COAL"

Statistics on 1920 Production of Electrical Equipment and Supplies

	Value	Number of Units
Insulated Copper Wire:		
Rubber-covered	$85,000,000	.....
Total code	30,000,000	1,700,000,000 ft.
No. 14	11,250,000	1,105,000,000 ft.
Flexible cords	.....	204,000,000 ft.
Motors:		
Fractional	40,000,000	.....
1 hp. to 50 hp	66,000,000	.....
51 hp. to 200 hp	11,000,000	.....
Above 200 hp	2,000,000	.....
Transformers:		
5 kva. and under	.....	330,000 kva.
Above 5 kva	.....	660,000 kva.
Distribution type	11,400,000	.....
Power type	13,200,000	.....
Meters, watt-hour	.....	2,200,000
Control, industrial	25,000,000	.....
Lamps:		
Type "B"	.....	172,000,000
Type "C"	.....	43,000,000
Carbon	.....	15,000,000
Miniature	.....	105,000,000
Socket Devices:		
Heating appliances:		
Domestic	21,250,000	.....
Heating pads	200,000	.....
Industrial	1,500,000	.....
Fans	20,500,000	1,700,000
Washing machines	72,000,000	600,000
Vacuum cleaners	45,000,000	900,000
Wiring Supplies:		
Rigid conduit	20,300,000	140,000 tons
Non-metallic flexible conduit	5,000,000	95,000,000 ft.
Metallic flexible conduit	150,000	2,300,000 ft.
Flexible armored conductor	6,400,000	71,000,000 ft.
Outlet boxes and fittings	1,800,000	.....
Tape:		
Friction	.....	18,000,000 lb.
Rubber	.....	2,000,000 lb.
Fuses:		
Renewable	3,500,000	.....
Non-renewable	3,500,000	.....
Schedule Material:		
Key sockets	.....	13,500,000
Pull sockets	.....	9,000,000
Keyless sockets	.....	5,500,000
Flush switches	.....	9,000,000
Exposed switches	.....	8,000,000
Plugs	.....	15,000,000
Receptacles	.....	15,000,000
Storage, Batteries	100,000,000	.....
Starting and lighting	52,500,000	3,500,000
Dry Batteries	.....	70,000,000
Electric Vehicles:		
Trucks	22,000,000	5,000
Industrial tractors	8,000,000	4,000

IN EXCESS of $1,250,000,000 is the conservative estimate of the manufactured value of the output of electrical materials during 1920.

In the table in the left-hand column are statistics of the year's output covering electrical engineering equipment and supplies so far as they pertain to electric light and power utilities, industrial plants, construction work and the household. The figures were compiled by the ELECTRICAL WORLD from estimates made by those who because of their connections should be able to give figures that are reasonably accurate.

This table does not include all electrical manufacturers, because in many instances no accurate estimates are available. No mention is made of wire or wireless communication, automotive equipment outside of starting and lighting batteries and lamps, medical equipment, generating equipment, farm plants and various other items which in the aggregate amount to many millions of dollars. The products listed here total around $750,000,000.

No items, with one exception, show any decrease from the values listed for the year 1919. But several of the lines do not show increases as great as they would have shown had raw materials been available to carry on the production made necessary to supply the insistent demands. Watt-hour meters provide one noteworthy instance. Although 1920 production is listed as 2,200,000 meters, it has been estimated that the industry could have absorbed about 2,500,000. Again, flexible armored conductor was produced to the extent of about 71,000,000 ft. The supply of steel strip was so limited during the first half of the year that production of finished conductor was hampered to a large extent. At the same time this reacted favorably to the increased production of non-metallic flexible conduit and knobs, tubes and cleats.

From the way the year started off, records gave promise of being badly broken in lines of socket devices. Fans and heating appliances increased well, but the demand for domestic motor-driven appliances, which started off with a rush, fell off in the last half year and production suffered greatly. Otherwise washing-machine figures, especially, would have been considerably higher. The same might be said of the production of starting and lighting batteries. Here is one case where 1920 production was probably under that of 1919 by about 500,000 batteries.

Lamp production has responded to a big increase. Sales of tungsten filament lamps increased from 170,000,000 in 1919 to about 215,000,000 in 1920. Miniatures have gone from 70,000,000 to about 105,000,000.

About $120,000,000 worth of motors were manufactured in 1920, surpassing 1919 by 20 per cent.

Conduit sales increased to a favorable extent. Rigid and flexible conduits total about $26,000,000, and to this may be added stone and fiber conduits. About 13,000,000 ft. of fiber conduit was produced in 1920.

Wire production was heavy all year, rubber-covered increasing about 13 per cent over 1919.

Transformer production amounted to 10 per cent more than it did last year, the power types going to 20 per cent.

Schedule-material production showed varying amounts for different items. Receptacles and plugs increased 50 per cent in 1920 over 1919, while sockets showed from 10 to 20 per cent increase. Flush switches held steady, but exposed switches increased 7 per cent.

Output for 1920 Estimated at 46,700,000,000 Kw.-Hr.

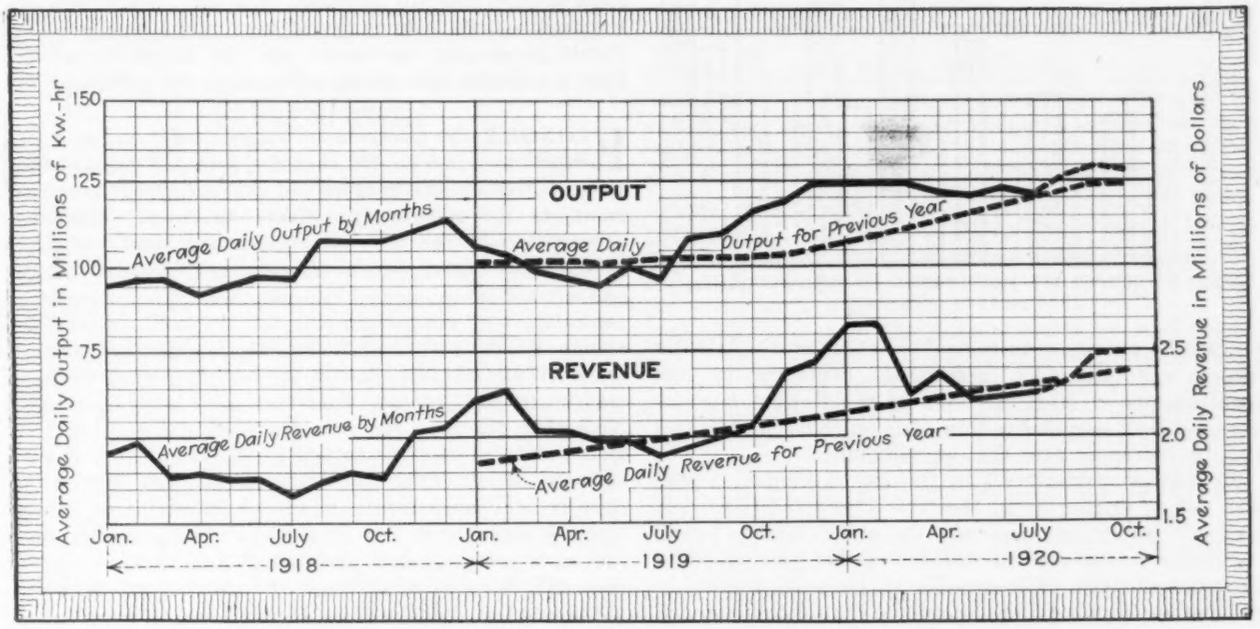


FIG. 1—CENTRAL STATION OPERATIONS SHOW DECREASE IN OUTPUT DURING OCTOBER

FOR the year just closed the central-station output was 46,700,000,000 kw.-hr., as nearly as can be estimated from returns received by the ELECTRICAL WORLD for the first ten months of 1920, while the total gross revenue is estimated at about $922,300,000. These figures represent an increased output over 1919 of 21.2 per cent and an increase in the revenue from the sale of energy of 19.2 per cent. Diagram 2 indicates that during the six-year period in which the ELECTRICAL WORLD has received regular monthly returns from electric light and power plants of the country the output has grown from 16,782,000,000 kw.-hr. in 1914 to the figure given above, a total increase in the six years of 178 per cent, and the revenue has grown from $336,980,000, an increase of 174 per cent. The following table gives the increase in central-station output throughout the country during the past six years:

Section	1914 Kw.-hr.	1920 Kw.-hr.	Gain in Six Years, per Cent.
New England States	1,217,900,000	2,892,200,000	137
Atlantic States	5,746,000,000	16,900,000,000	194
Central States	6,413,500,000	17,768,400,000	177
Mountain and Pacific States	3,404,700,000	9,139,400,000	168

The returns received for the month of October of last year reflect the large curtailments in production prevalent throughout the plants and factories of the country. In spite of the large seasonal increase in energy demand for lighting purposes, the average daily output for October was only 127,400,000 kw.-hr. against 128,300,000 kw.-hr. reported for September. Despite the decrease in energy sold to power customers, the usual large seasonal increase in lighting requirements was sufficient to produce a slight increase in the gross earnings for the month.

Every section of the country excepting the Atlantic States showed a decrease in output for October under that of September. From New England came reports of curtailments in nearly every manufacturing industry, and few factories were working on a six-day schedule. As a result the central-station industrial load of that section suffered materially, the daily output averaging 7,720,000 kw.-hr. against 7,900,000 for September.

Similar factory production curtailments occurred in the Atlantic States. In the South Atlantic States, however, more than 158,000 more spindles were active in October than during September, and for the most part the steel companies of the Middle Atlantic States were operating at about 80 per cent capacity. The decrease

TABLE I—CENTRAL-STATION RETURNS FOR TWELVE MONTHS

	Percentage of Installed Ratings Represented	Revenue from the Sale of Energy			Percentage of Installed Ratings Represented	Kw.-Hr. Output		
		1919 Thousands	1918 Thousands	Per Cent Increase		1919 Thousands	1918 Thousands	Per Cent Increase
Nov.	53	$37,439	$31,927	17.2	58	2,055,428	1,895,693	8.2
Dec.	59	44,125	37,978	16.0	65	2,509,571	2,270,833	10.0
		1920	1919			1920	1919	
Jan.	57	46,614	39,002	19.8	67	2,581,096	2,186,732	18.0
Feb.	63	45,881	37,502	22.1	69	2,494,764	1,986,493	25.3
Mar.	65	46,155	36,840	25.0	70	2,698,890	2,103,587	28.0
April	65	45,547	36,541	24.5	70	2,603,692	2,098,559	24.1
May	65	43,888	35,512	23.4	70	2,631,560	2,179,916	21.2
June	66	44,434	35,528	24.5	71	2,630,831	2,175,645	20.2
July	66	46 608	36 265	28 5	71	2 677,131	2.234 215	20 0
Aug.*	66	47,410	36,713	29.1	71	2,769,175	2,303,099	20.1
Sept.†	66	49,084	38,214	28.2	71	2,737,056	2,324,215	18.7
Oct.‡	66	51,008	40,979	25.1	71	2,802,357	2,493,710	12.5

*Includes estimates for twenty-four companies, representing 2.5 per cent of the total installed rating of all central stations.
†Includes estimates for forty-one companies, representing 9.2 per cent of the total installed rating of all central stations.
‡Includes estimates for ninety-three companies, representing 17.6 per cent of the total installed rating of all central stations.

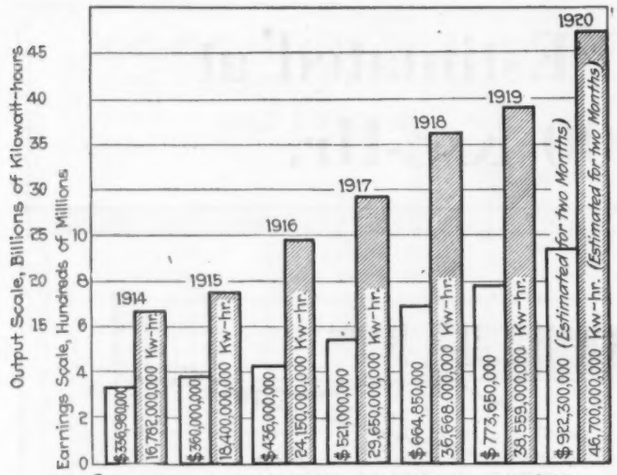


FIG. 2—OUTPUT AND EARNINGS OF CENTRAL STATIONS, 1914 TO 1920 INCLUSIVE

in factory energy requirements of the North Atlantic States was, therefore, apparently overcome by the requirements of other portions of the section, and the average daily output for this division consequently was slightly increased over that of September.

Production curtailment in the North Central States was not so drastic as in the New England States, but was sufficient to cut materially the energy sold to power customers by the central stations of that section. The daily consumption of energy for all purposes was about 300,000 kw.-hr. below that reported for September.

The rising importance of the industrial load in the Southern States is emphasized in the October returns for that section. Until very recently the energy requirements of these states could be gaged very accurately by the seasonal demand for lighting, but in October, in spite of the advancing season, the central-station output averaged 150,000 kw.-hr. less than during the month previous.

For the first time in the year the output of the Mountain and Pacific States showed a decrease under that of the previous month. The Northwestern States showed a distinct gain in output during the month, but the reduced output reported from California was sufficient to overcome this increase. The large proportion of the total output sold to power customers by the California generating companies and the slump in industrial production are clearly reflected by the returns.

ECONOMY *in government expenditures is now of vital importance. We should expect and demand the same degree of efficiency in the conduct of our government as we require in private business. Reckless expenditure by the government, national, state or city, necessitates higher taxes. These taxes increase prices, and higher prices curtail consumption. The effect of a curtailment of consumption is to increase non-employment. There is need of immediate revision of our tax laws. While the war lasted we had to put up with a makeshift policy, badly conceived and badly executed. Now that the time for real readjustment has come it is the duty of citizens to see to it that taxes are not imposed which encourage extravagance and take from industry the opportunity to invest its earnings. Only by such investments can factories be kept running, and the more factories kept running at full time, the more men will be required to work, the greater will be their output and the higher their wages. If the business of the United States is to go forward as it must go forward, our people must take a world view. We must think internationally. We must trust in the good faith and in the productive power of Europe, sending to them our raw materials and goods to enable them to resume productivity.*—CHARLES M. SCHWAB.

TABLE II—CENTRAL-STATION RETURNS BY SECTIONS OVER A TWELVE-MONTH PERIOD

	Month	New England States				Atlantic States				North Central States				South Central States				Pacific and Mountain States		
		Percentage of Installed Ratings Represented	1919 Thousands	1918 Thousands	Per Cent Increase	Percentage of Installed Ratings Represented	1919 Thousands	1918 Thousands	Per Cent Increase	Percentage of Installed Ratings Represented	1919 Thousands	1918 Thousands	Per Cent Increase	Percentage of Installed Ratings Represented	1919 Thousands	1918 Thousands	Per Cent Increase	Percentage of Installed Ratings Represented	1919 Thousands	1918 Thousands	Per Cent Increase
REVENUE	Nov.	71	$4,432	$3,800	16.2	56	$14,738	$12,761	15 7	44	$10,541	$8,689	21.2	39	$2,063	$1,694	21.8	63	$5,665	$4,983	13.9
	Dec.	73	4,908	4,254	15.1	57	15,926	13,806	15.8	49	11,660	9,833	18.3	44	2,496	2,070	20.0	77	9,135	8,015	14.2
			1920	1919			1920	1919			1920	1919			1920	1919			1920	1919	
	Jan.	78	5,635	4,718	19.8	59	17,659	14,625	20.9	51	12,885	10,799	19.6	53	3,047	2,538	19.9	75	7,388	6,322	16.1
	Feb.	82	5,354	4,368	22.1	61	17,245	14,343	20.4	55	13,191	10,403	26.0	53	2,949	2,360	24.7	79	7,142	6,028	18.3
	Mar.	82	5,136	4,044	27.0	63	17,696	14,299	23.7	57	13,270	10,469	26.5	54	2,910	2,287	27 8	79	7,14:	5,741	24.2
	April.	82	5,087	3,943	29.0	64	17,700	14,383	23.5	57	12,690	10,042	26.9	54	2,952	2,181	35 .2	79	7,118	5,992	19.2
	May	82	4,897	3,741	30.1	64	16,624	13,631	21.9	57	12,471	9,853	26.8	54	2,829	2,140	32 0	79	7,067	6,147	15.1
	June	82	4,948	3,778	30.5	65	16,525	13,449	22.1	57	12,412	9,77(	26.9	54	2,849	2,127	33.9	79	7,700	6,398	20.5
	July	82	5,009	3,8?2	28.5	65	16,8 9	13,438	25 5	57	12,822	9,?03	30.9	54	2,?7	2,194	5 (	79	9,131	6,948	31.5
	Aug.	82	5,075	4,093	24 0	65	17 210	13,731	25 9	57	13,497	10,151	32 9	54	3,168	2,281	38 1	79	8 460	,,457	31.1
	Sept.	82	5,407	4,293	25 9	65	18 012	14 449	24 2	57	13,767	10,525	30 5	54	3,230	2 386	35 4	79	8 668	6,571	32.1
	Oct.	82	5,673	4,616	22 9	65	19,123	15,675	21.9	57	14,312	11,654	22.8	54	3,343	2.547	30 9	79	8 557	6,487	32.1
			1919	1918			1919	1918			1919	1918			1919	1918			1919	1918	
KW.-HR. OUTPUT	Nov.	71	153,171	140,240	9.2	56	724,607	707,347	2.4	60	686,486	597,855	14.9	39	68,352	59,507	14.7	63	422,812	390,744	8.2
	Dec.	73	180,493	152,304	18.0	58	803,165	733,222	8.9	67	825,313	713,959	15.8	44	88,658	73,728	20.1	77	611,942	597,620	2.5
			1920	1919			1920	1919			1920	1919			1920	1919			1920	1919	
	Jan.	78	207,158	159,773	29.8	60	853,057	717,303	19.2	69	841,841	731,758	15.2	56	140,736	117,677	19.9	75	538,304	460,221	16.2
	Feb.	82	187,264	148,103	26.2	62	809,865	672,836	20.1	73	858,939	663,523	29.4	56	130,473	98,098	33.0	79	508,223	403,933	26.1
	Mar.	82	198,603	148,512	33.7	64	897,327	711,828	26.0	74	913,659	711,761	28.1	56	137,306	102,545	33.6	79	551,995	428,941	28.6
	April.	82	187,174	144,922	29.1	65	883,264	701,778	25.9	74	857,467	687,751	24.7	56	135,140	99,877	35.2	79	540,647	464,231	16.7
	May	82	188,566	148,186	27.5	65	854,631	711,276	20.0	74	862,127	700,095	23.5	56	137,779	98,815	39.2	79	588,457	521,544	12.6
	June	82	189,934	149,607	26.5	66	8 5,714	721,688	19.9	74	855,013	681,780	25.5	56	137,733	99,660	33.2	79	587,437	522,901	12.2
	July	82	190,668	159,000	20.0	66	88 ,241	7 4,485	23.5	74	841,351	702,302	19 7	56	138,937	106,460	30 1	79	6 4,934	551,959	13 4
	Aug.	82	194,028	171,002	13.	66	905,170	728 097	24.2	74	891,712	750,787	18 6	56	147,082	111,573	32 0	?	631,183	541,640	16 5
	Sept.	82	194,610	170,314	14 0	66	906 353	758 287	19.5	74	876,770	754,855	16 0	56	146,5 1	113,212	29.9	79	60 ,80	527,547	15.5
	Oct.	82	196,097	190,713	2.6	66	965,665	840,189	14.7	74	900,985	814,14?	10 6	56	148,800	124,250	19.8	79	5.0,810	523,816	10.5

Station and Operating Practice

A Department Devoted to Problems of Installation, Operation and Maintenance of Equipment for Economical Generation and Distribution of Electrical Energy

Recent Equipment Costs in Massachusetts Central Stations

IN VIEW of the interest of engineers in equipment costs at present the following segregated data are published for several Massachusetts central stations filing construction-cost information with the Department of Public Utilities in connection with petitions for authority to issue securities. Only such data as are of general significance are presented, but virtually all these costs are 1919-1920 figures.

One 12,500-kva. turbo-generator, erected	$195,397
One 22,000-sq.ft. surface-condensing equipment with exhaust distance piece	69,840
One 4,300-kva., 25-cycle, three-phase, 11,000-volt generator, erected	60,200
Two 755-hp. water-tube boilers	36,886
Two 755-hp. Foster superheaters, erected	7,350
Two seven-unit Diamond soot-blowing equipments	1,544
Two seven-retort underfeed stokers with steam-power dump	11,666
Four 36-in. cast-iron ash gates	1,303
One air washer, 40,000 cu.ft. per minute	2,328
One 2,000-lb. electric weighing lorry	2,100
One 30-in. hydraulically operated atmospheric relief valve	1,125
One No. 8 green forced-draft fan	6,800
One 50-ton, four-motor electric crane	16,410
Two superheaters for 500-hp. boilers	8,223
Two 1,500-barrel steel fuel-oil tanks with foundation	16,738
Oil-burning equipment for 15,000-kva. station	90,379
One 150-kw. combination turbo-motor exciter set	9,375
One 20-ton, eight-wheel locomotive crane with 60-ft. boom	15,985
Two 1,200-amp. and fourteen 600-amp., 15,000-volt solenoid-operated oil circuit breakers	19,725
Three 1,250-kva. transformers, 66,000/13,000 volts, water-cooled type	16,200
Three 1,500-kva., 66,000/13,200/2,200-volt water-cooled transformers	19,600
Water-cooling system for three 1,500-kva., 66,000/13,200/2,200-volt transformers	1,704
Three 2,500-kva. transformers, 23,000-4,000-volt, installed, including switching and connections	20,533
Six 1,000-kva. transformers, 13,200/2,300-volt, single-phase, 60-cycle, oil-insulated, self-cooled, outdoor type for bus-tie work	13,388
Four 100-kva., 2,300/230/115-volt oil-insulated, self-cooled transformers, indoor type, auxiliary station service, single-phase, 60-cycle	2,222
One 1,300-amp., 6-ohm, 15,000-volt, 350-deg. C. (1 minute) neutral-grounding resistor for 12,500-kva. generator	2,600
Two 13,200-volt, three-phase, 60-cycle oxide-film lightning arresters, with fuses, etc., for 13,200-volt bus	1,122
One 46-kva., 200-amp., 2,200-volt, 60-cycle feeder-voltage regulator, complete with three-phase non-automatic motor control, f.o.b. factory	1,272
Five 66,000-volt potential transformers	9,540
One 66,000-volt air-break switch	970
Four 200-amp. and five 300-amp. feeder reactors	8,108

Steam Leakage Through 0.001-Sq.In. Hole Wastes $40 per Year

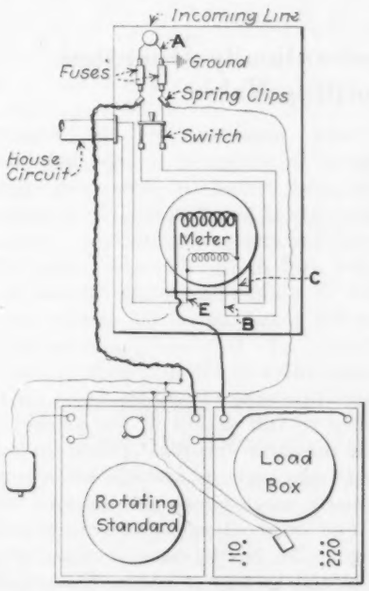
ABOUT 100,000 lb. (45,000 kg.) of steam per year will leak through a hole having an area of only 0.001 sq.in. (0.006 sq.cm.) with a pressure of 200 lb. (14 kg.) on the steam. With coal at $5 per ton and 6 lb. (2.7 kg.) of water evaporated for 1 lb. (0.45 kg.) of coal, this will amount to about $40 per year for extra fuel on account of the leak. It is seen from these figures that the cost of additional fuel which is necessary on account of small leaks is much greater than would be expected from a hasty consideration. Leakage of steam from pop safety valves is a frequent cause of loss. These can be shut tight and made so there is no chance of leakage under operating pressure. Leakage into cold boilers is another cause of very considerable loss in almost all plants. Leakage through throttle valves and by-pass connections of idle prime movers, auxiliary engines and pumps is a universal source of loss. Other points where steady leaks are found are valves in drip or drain pipes from steam piping, superheaters, and throttle valves, in couplings, unions and holes in valves and fittings, water-columns, blow-off cocks and floor pumps, steam traps, pressure-gage connections, boiler seams, etc. The fact that an engine shows a nearly perfect indicator diagram is not absolute proof that the engine is operating economically as these leaks may lower the over-all efficiency.

The blowing of high and low-water alarm whistles of water columns is another source of waste, and so sometimes is blowing off steam through boiler and economizer pop safety valves. It is necessary to blow these valves only once every day to test them momentarily. Another source of loss is the use of too much steam under grates for protection against burning or to facilitate the combustion of coal.

H. F. EDDY,
Consumers' Power Company, Mechanical Engineer.
Jackson, Mich.

Outfit for Speedy Testing of Meters

AN OUTFIT for testing customers' meters which is convenient, speedy and easy to handle was designed by the writer for the Depew & Lancaster Light, Power & Conduit Company, Lancaster, N. Y. A rotating standard and load box are inclosed in one case. Only three connections are made and only one service wire is removed from the meter. The apparatus consists of a Westinghouse rotating standard watt-hour meter and a States Company type F phantom-load box mounted in a hardwood case lined with ½-in. (1.25-cm.) felt. The load box is set at a 30-deg. angle to allow insertion of the potential plug in front, radiation from the back and a view of the load point markings on top. The three leads are cabled and fold inside the case for carrying. The customer's meter in the drawing is Westinghouse OA, and current connection for the test is made to the left terminal after removing the distribution wire *E*. This meter has right hand feed. For meters with left hand feed the procedure as outlined



ONLY ONE LEAD OF METER NEED BE REMOVED FOR TESTING

is reversed accordingly. The incoming service leads at the right remain in normal position to liven the meter potential coil. Two snap connections are made at the service fuses. The current wire connected at the left-hand fuse is extra-heavy lamp cord, and ordinary lamp cord is soldered to it at the top and twisted around it down to the test outfit for one potential of the standard meter. The other potential wire is run separate to the right-hand fuse. As these connections are made at the incoming point error due to voltage drop is eliminated. The current when being tested passes from load box through meter to left-hand fuse and back over the heavy lamp cord to the rotating standard and thence to the load box.

The directions followed by the tester are as follows:

1. If either wire is grounded, it must be on the *A* side of the service as indicated.
2. If found otherwise, change to the *A* side.
3. *A* side must go to the *B* terminal of the meter.
4. Other side of service goes to *C* terminal of meter.
5. Remove distribution wire from terminal *E* of meter.
6. Set rotating standard to the proper amperage and voltage.
7. Set load box dial below lowest point.
8. Make connections according to the sketch.
9. Put the plug in the load box at the proper voltage.
10. Proceed with the test.
11. Be sure customer has service before leaving.

The tester always sets the load-box dial below the 0.1-lamp point while connecting up. After bringing the dial to this position if the connections are wrong this coil will blow, thereby protecting the rest of the outfit. It is only necessary to wind on a few feet of resistance wire, with which the tester is supplied, to make the outfit serviceable again.

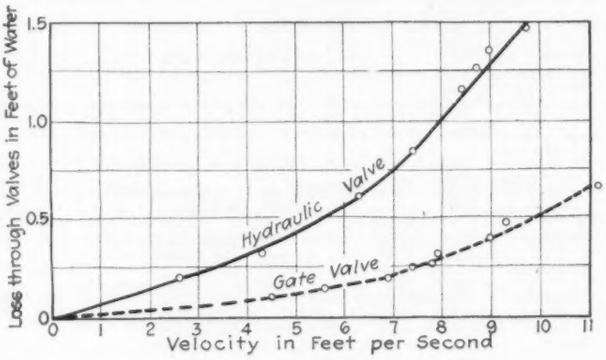
B. R. PAYNE,
Meter Superintendent.
Depew & Lancaster Light, Power & Conduit Company,
Lancaster, N. Y.

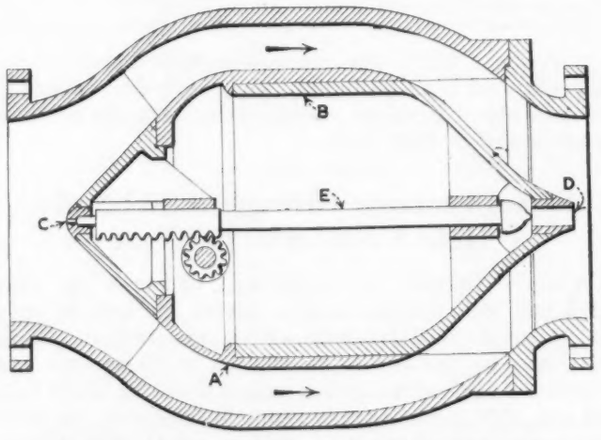
Test of a Hydraulically Operated Throttling Valve

A THROTTLING valve operated by the water pressure in the main in which it is inserted has recently been installed and tested in the hydraulic laboratory of the University of California. This valve is of considerable interest because of its probable use in the Hetch-Hetchy project and in the filtration plant at Sacramento. The valve is diagrammatically shown in the sketch. The following are some of the advantages found in this type of valve: (1) It is easily and rapidly closed. The 6-in. (15-cm.) valve in the hydraulic laboratory was closed against a pressure of 150 lb. (10.5 kg.) in six seconds and opened to full extent in five seconds. A standard gate valve of the same size was opened under the same conditions in twelve seconds and closed in ten seconds and required many more times the amount of muscular effort. (2) The internal parts are machined and require no packing. (3) No by-pass is required. (4) The valve can be placed in any position of partial closure and left indefinitely without injury. (5) Tightness. This valve was closed against a pressure of 150 lb. per square inch and showed no signs of leakage. (6) Wear. Although the valve had been used by the Niagara Falls Power Company before it was presented to the university it shows no signs of wear, and because all of the parts subjected to pressure are circular there is no tendency to distortion.

Some disadvantages are: (1) That the valve may be closed so rapidly as to produce an exceedingly strong water hammer, and (2) that for full-open position the loss through the valve is greater than through a gate valve of the same size. A comparative test was made on the two valves for head loss with different velocities. The results are shown in the curves reproduced.

The valve operates in the following manner: The internal cylinder *A* is supported by radial ribs. Within the cylinder *A* the piston *B* is actuated by the piston rod E. It will be noted that the valve closes with the direction of flow. If we start with the valve in the open position as shown and turn the pinion toward the right, the piston rod *E* moves toward *D*. Water enters at *C* and produces within the cylinder a pressure which is greater than that on the front side of the plunger because at *D* the water is flowing while within the cylinder it is at rest. It must be remembered that the opening *C* is very small compared with that at *D*. This permits the relative decrease of pressure through *D* and at the same time a relative increase through *C*. The tendency then is for the plunger *B* to move forward. This it does, but it can move only a very short distance because it moves away from the piston rod at *D* and thus creates within the cylinder a pressure equal to that outside and the plunger would stay in this position of





HYDRAULIC VALVE CLOSED BY PRESSURE OF THE WATER

The curves show comparative head losses of the hydraulically operated valve and a gate valve under varying velocities.

equilibrium if the hand wheel is not again revolved and the whole process repeated.

If the valve is operated in air or in still water, the piston rod closes the plunger *B* by sliding it along. A reversal of the above operation opens the valve.

University of California, BLAKE R. VANLEER,
Berkeley, Cal. Instructor in Mechanical Engineering.

Industrial Applications

The Economical Utilization of Electrical Energy in Mills and Factories, Together with Practical Details of Installation, Control, Testing and Repair of Equipment Required

Temperatures for Switches, Buses and Bare Conductors

MAXIMUM operating temperatures which should be allowed in switches and bare conductors and buses were agreed upon by the Electric Power Club at its November meeting. According to the recommendations of the club, switching devices should carry continuously their rated current and the rated currents of the circuits in which they are applied, without exceeding the temperature-rise limits set by the A. I. E. E. standardization rules. These ratings are based on an ambient temperature of 40 deg. C.

Maximum temperature of contacts in air when clean and bright and maximum temperature of oil and contacts therein must not exceed 70 deg. C. Maximum temperature on coil insulation, according to insulation, shall not be above 108 deg. C. to 125 deg. C. (except that in the case of such materials as pure mica, porcelain, etc., no limits are specified). Maximum temperature of other parts, including frames, may reach such temperature as shall not be injurious in any other respect.

Fuses, shunts for meters and resistors which must necessarily operate at temperatures higher than the foregoing limits will be placed so that they will not increase the temperature of other apparatus above the limits stated.

Bare buses and bare conductors may be operated at temperatures not exceeding 90 deg. C. provided that their location or connection does not increase the temperature of connected switching devices above 70 deg. C., or of connected insulated conductors above that specified in the A. I. E. E. standardization rules. Where insulated conductors are used their temperature rise shall not exceed that specified by the A. I. E. E. rules.

Motor Record System for Plant with Several Departments

A SYSTEM for keeping track of motors in use by the Dayton Engineering Laboratories Company is complete and simple to use. There are three files. One placed in the main office contains 4-in. x 6-in. (10-cm. x 15-cm.) cards, bearing the shop number of each motor and the name of the department in which it is installed. In each department there is another file with cards of the same size containing nameplate, winding and other data.

A white card is employed for alternating-current motors and a red card for direct-current machines. It will be noted on the card shown here that the specification numbers of the rotor and stator as given on the nameplate are also shown on the record card. This is important with motors manufactured by certain companies, because the letter at the end of the specification number indicates the manner in which the windings are connected.

A detail of the record that is very carefully kept is the size and description of the bearings. Bronze bearings sometimes scar the shaft to such an extent that it has to be turned down and will no longer take a standard bearing. In such cases the exact size of the bearing required is shown on the record. Spare rotors are put in service while shafts or bearings have to be repaired. Special bearings are made for a shaft as soon as it has been turned down, and the rotor is put in stock complete with the special bearings on the shaft ready for service.

Delco	Make		Serial
H. P.	Volts	Type	Frame
Form	Phase	Cycle	R. P. M.
Spec. Nos. Stator	Rotor	Amp.	
Bearings-F	Rear	Type	
Rotor Amp	Rotor Voltage		Total Coils
Slots	No. Brushes	Kind	Size
Stator Connections			Drawing No.
Pulley	Bore	Diam.	Key

CARD FOR DATA ON AN INSTALLED MOTOR

The third file is a permanent motor record in a loose-leaf book in the main office, in which the motors are filed according to horsepower and speed. The records of about twenty-five motors can be entered on one page and at least one page is allowed for each motor and size.

The best of records needs checking. This is done by means of an inventory of the motors made every six months by the men who inspect and oil them. These inventories serve the double purpose of maintaining the accuracy of the records and checking up on the work of the inspectors.

H. L. BURNS,
Chief Electrician.

Dayton Engineering Laboratories Company,
Dayton, Ohio.

Operating Records of Brass Furnace Pouring Directly Into Molds

ABOUT 250 kw-hr. is consumed for each ton of yellow brass melted in the casting shops of a large brass mill operating in Ohio. Six or seven heats are usually poured in a day of ten hours, and when the furnace is warmed up the average time between the heats is one hour and fifteen minutes, made up of ten minutes for charging, fifty minutes for melting and fifteen minutes for pouring. It will be noted from the typical daily report that the energy consumption dropped from 260 kw.-hr. on the first heat to 200 kw.-hr. on the sixth, as the furnace became hotter with each succeeding heat. On that day the charges consisted of 2,178 lb. (897 kg.) of ordinary yellow brass scrap;

10 lb. of grade D zinc, which contains approximately 0.4 per cent of lead, and 12 lb. (5.5 kg.) of lead. The furnace was a 1-ton (900-kg.) Detroit rocking electric brass furnace and the metal was poured directly into the molds.

Eliminating the ladle in this mill has saved the cost of replenishing crucibles. A number of difficulties were encountered when this practice was first tried, but they have been overcome by carrying the molds on a truck

MELTING YELLOW BRASS, 2,200 LB. PER HEAT

	Heat No. 1	Heat No. 2	Heat No. 3	Heat No. 4	Heat No. 5	Heat No. 6
Time arc was turned on	7:05	8:45	10:35	12:00	1:25	3:00
Meter reading, kw.-hr.	0	0	0	0	0	0
Time rocking started	7:45	9:30	11:10	12:33	2:00	3:30
Meter reading, kw.-hr.	150	150	150	135	130	130
Time arc was turned off	8:15	10:10	11:25	12:55	2:25	3:45
Meter reading, kw.-hr.	260	250	240	232	212	200

operating on 30-lb. (13.5-kg.) rails. The four molds are so placed on the truck that each mold is elevated 6 in. (15 cm.) above the preceding one in order to bring the mold as close as possible to the pouring spout and to reduce the spill to the minimum. The truck is moved back and forth under the furnace spout by means of a rack and gear controlled by a hand-operated wheel, and the arrangement has proved very satisfactory.

The metal for the furnace is taken from the metal storage room to the charging platform in steel pans of approximately 200 lb. (90 kg.) capacity by means of an overhead conveying system. The furnace can then be filled with 2,000 lb. (900 kg.) of metal from the charging platform in about ten minutes.

JAMES F. BRUSSTER,
Assistant Mechanical Engineer.
Cleveland Brass & Copper Mills, Inc.,
Cleveland, Ohio.

Correct Current Values for Welding with Metallic Electrodes

CORRECT current value is an important feature in electric welding. This fact was demonstrated in a series of tests made by the welding committee of the National Research Council and Emergency Fleet Corporation. In these investigations a number of $\frac{1}{2}$-in. (13-mm.) plates were welded in sixteen different plants under identical conditions as to material and size of plates. Although several types and sizes of electrodes were used, including bare and covered, and both direct

CURRENT TO BE EMPLOYED IN WELDING MILD-STEEL PLATES

Electrode Diameter, Inches	Plate Thickness, Inches	Amperes
$\frac{1}{16}$	up to $\frac{1}{8}$	25- 50
$\frac{5}{32}$	up to $\frac{1}{4}$	50- 90
$\frac{1}{8}$	$\frac{5}{16}$ to $\frac{1}{2}$	75-160
$\frac{5}{32}$	$\frac{5}{16}$ up	125-200
$\frac{3}{16}$	$\frac{1}{2}$ up	175-250

and alternating current were employed to make the welds, an analysis of the results of physical tests, such as tensile, elongation, bending and fatigue tests, revealed no noteworthy difference in the mechanical characteristics, whether the welds were made with bare or flux-covered electrodes or with alternating or direct current. However, it was noticed that the strongest and most ductile welds were made with a high current.

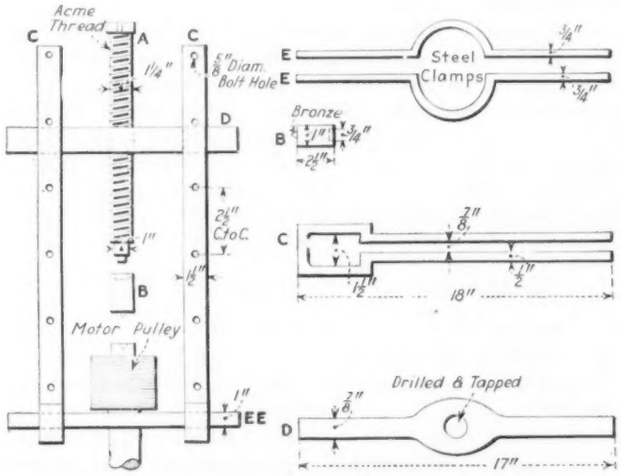
The currents which seem to be the most favorable for mild-steel plates are listed in the accompanying table. The same size of electrode may be used with various thicknesses of plate, using the higher limits of current noted in the table with the heavier plate. In general, the larger size of electrode permits greater speed of welding but requires greater skill and care on the part of the operator. However, there are decided limitations to the increase in speed which may be obtained in this manner.

Excessive current causes a "cutting" arc which either burns holes in the work or else melts the electrode material so rapidly that it piles up and does not insure perfect fusion with the parent metal. To avoid these undesirable factors the operator is compelled to work intermittently to allow the work to cool somewhat. This waste in time more than offsets the gain in the rate with which the electrode is deposited. The general conclusion seems to be that the average operator should use higher current than has heretofore been the practice.

WILLIAM SPRAGEN,
Secretary Engineering Division, National Research Committee.

Home-Made "Come-Along" for Drawing Motor Pinions and Pulleys

PINIONS, gears and pulleys are easily removed from motor shafts in the Chapman valve shops by the screw brace and clamping outfit illustrated in the accompanying sketch. To remove a pinion from a motor shaft the pair of clamps *EE* are placed above and below the shaft and against one side of the pinion; the centering piece *B* is placed in the shaft end and is followed up by the plugged end of the screw *A*, which is 1¼ in. (3.18 cm.) in diameter, with an Acme thread.



PULLEY REMOVED FROM MOTOR SHAFT BY TURNING SCREW *A*

By turning the latter with a wrench the shaft is virtually pushed out of the pinion. The centering piece *B* is of bronze, and the other pieces of the clamping device are mainly wrought-steel bars, provided with bolt holes to facilitate adjustment for different sizes of pinions and pulleys and knocking down for easy transportation to and from different parts of the plant.

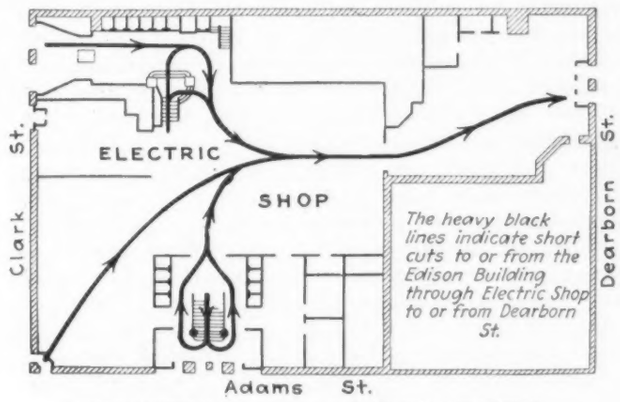
WALTER B. ATCHINSON,
Electrical Engineer.
Chapman Valve Manufacturing Company,
Indian Orchard, Mass.

Central Station Service

A Department Devoted to Commercial Policy and Management Topics, Including Methods of Increasing the Use of Electric Light, Power and Heat

Department-Store Methods Applied to Electrical Store

SINCE the extension of the electric shops of the Commonwealth Edison Company, Chicago, to Dearborn Street, an "electric thoroughfare" has been created between Dearborn Street and Clark Street. This short cut is used daily by thousands, and in order to encourage more persons to go through the shops the accompanying diagram has been printed and distributed. The scheme has been instrumental in increasing traffic through the shops and has helped solve the problem of showing the


Clark St.
ELECTRIC
SHOP
The heavy black lines indicate short cuts to or from the Edison Building through Electric Shop to or from Dearborn St.
Dearborn St.
Adams St.

COMMONWEALTH EDISON COMPANY'S "ELECTRIC THOROUGHFARE"

public the merchandise on sale in a retail electric store. This is an application to electrical merchandising of one of the department store's business axioms. The experience of general retail stores, that, other things being equal, sales are proportional with the number who see the goods, is proving true also in the electrical shop.

Employees Prefer Insurance to Turkeys for Christmas

AT THE request of territorial councils, consisting of company and employee representatives, the Public Service Company of Northern Illinois has agreed to insure its employees at a cost of about $24,000 per annum instead of following the customary practice of giving each employee a turkey for Christmas at a total cost of about $10,000. When the insurance goes into effect every employee who has been with the company three months will receive a policy, and those who have not been with the company for that length of time will receive a policy at the end of three months' service. Future new employees after six months' service will be entitled to the insurance, which starts with a policy of $500 and increases with the length of service to $1,500 for those who have been with the company for more than six years. The insurance will cost the company about $21,000 the first year for a total of 1,750 employees. However, to the cost of the premiums must be added about $3,000 for the necessary office work and details in connection with carrying out the scheme.

The average age of the employees is now thirty-three years, but as business conditions become stabilized it is expected that the labor turnover will decrease, so that the average age will increase. This may raise the annual cost to around $30,000 within a few years. When put to a vote of the employees 73.8 per cent expressed a preference for the insurance. If an employee leaves the company, he has the privilege of converting his company policy into a regular insurance policy without medical examination.

Utility and Newspaper Production Costs Compared

AN INTERESTING comparison of the increases in production costs of newspapers and gas and electric companies was prepared recently by the Illinois Committee on Public Utility Information. The percentages of increases from Aug. 1, 1914, to Jan. 1, 1920, and additional increases from Jan. 1 to Sept. 1, 1920, are shown to be as follows:

NEWSPAPER PRODUCTION COSTS

	Per Cent Increase Jan. 1, 1920, Over Aug. 1, 1914	Additional per Cent Increase Sept. 1, 1920, Over Jan. 1, 1920
Print paper	212.50	48.75
Ink	200.00	16.55
Metal	108.00	*4.00
Machinery, equipment	104.00	20.00
Twine	225.00	*3.55
Labor	91.75	10.87

GAS AND ELECTRIC COMPANY PRODUCTION COSTS

	Per Cent Increase Jan. 1, 1920, Over Aug. 1, 1914	Additional per Cent Increase Sept. 1, 1920, Over Jan. 1, 1920
Bituminous coal	126.06	37.5
Anthracite coal	152.77	3.19
Coke	103.53	101.23
Gas oil	200.00	83.33
Oxide	110.53	15.00
Firebrick	140.00	27.78
Pipe	149.82	19.63
Labor	79.88	21.35

(Fuel and labor constitute more than two-thirds of the operating costs of these companies.)
(Paper and labor are the largest cost of a newspaper.)

*Declines.

It is pointed out that newspapers have increased their subscription rates from 100 to 200 per cent and their advertising rates from 50 to 150 per cent. This was done without any state regulation or jurisdiction over their rates, while the utilities, whose costs of production had increased in equally large proportion, were unable to obtain relief except by recourse to the state regulatory body, which frequently entailed delays and postponements when emergency action was needed.

Economical Electric Water Heating for Barber Shops

QUICK and satisfactory service is afforded barber shops in Concord, Mass., by electric water-heating installations, of which that illustrated is representative. Every barber in Concord and Concord Junction is using electricity for this work. In one shop the tank photographed was installed complete with wiring for $48. The heating element is a General Electric cartridge unit rated at 1,000 watts, 220 volts, and the tank is 18 in. high and 10 in. in diameter, jacket-insulated and mounted on a low shelf in an unused corner. For convenience an ordinary three-heat switch was installed with the terminals changed so that the neutral wire can be used in getting 110-volt service for a low heat of 250 watts. The average energy consumption is about 150 kw.-hr. a month, the heating rate being as follows: First 50 kw.-hr. per month, 3 cents each; net 50 kw.-hr., 2½ cents each, and all over 100 kw.-hr., 2 cents each, making a bill of $3.75 per month.

ELECTRICALLY HEATED WATER TANK

Saving Effected by Leaving Disconnected Meters on Premises

THE meter department of the Iowa Railway & Light Company of Cedar Rapids, Iowa, has worked out for its convenience a system whereby the necessity for immediately removing meters on order for disconnection is obviated. It is believed that the system not only eliminates considerable work, but lengthens the life and reduces maintenance cost of meters and of meter loop.

When an order for disconnection of service is received the slip is marked with a rubber stamp on which four lines read, "Installed," "Removed," "Connected" and "Disconnected." Beside the line marked "Disconnected" a check is placed, completing instructions to metermen.

When the disconnection is made both the line wire and the shunt wire are placed together in the line binding post. The meter is then sealed, and in sealing a tag is fastened to the meter which reads: "This meter has been disconnected by the Iowa Railway & Light Company and must not be tampered with. If connection is desired, call the Iowa Railway & Light Company."

In the office of the meter department, when a disconnection order comes back with the notation "Disconnected," the meter record card (containing the meter number, address where located and space for removal date) is taken from the live-meter file, marked "Disconnected," together with the disconnection date, and placed in a convenient file. When an order for service comes in reference to this file shows at once whether it is necessary to take a meter to the address in order to make connection, for in all cases where a meter is merely disconnected a card will be found in the file.

If a new order for connection comes in from the address given on the card the card is taken from the "Disconnected" file and restored to the live-meter file. If after thirty days no connection order has come in the meter is taken out, and the card is marked "Removed" and placed in the closed-account file, indicating that the meter is again in the storeroom of the company.

Public Misinformed About Regulation, Says Missouri Commissioner

LACK of intelligent information and much misinformation characterize the present status of utility regulation, declared Noah W. Simpson of the Missouri Public Service Commission in an address before the annual convention of the Missouri Telephone Association. Commission regulation has developed with such rapidity that, while it is firmly established, it is by no means fully understood or appreciated by the general public.

The passing of municipal control of the utility to state jurisdiction has not been accomplished without opposition, Mr. Simpson pointed out. "You hear much nowadays," he said, "about the slogan 'Home rule' for local control of the utilities, but be not deceived, for you are only being presented with the old pill, sugar-coated, to the end that the state shall lose its jurisdictional control and the city politicians re-establish the old régime."

Alluding to the difficulties which have beset the commissions, he called attention to the fact that state regulation had to pass through the crucial period incident to the great war before it was firmly established and better understood by the public. "It is common knowledge that the component elements which go to make up the finished product of all utilities have enormously increased in value, yet there are those who would have these corporations furnish service at pre-war prices," Mr. Simpson continued. "The plain fact is that unless the regulatory bodies had provided increased operating revenues for these utilities they would soon have been bankrupt and the public without service."

Electricity Cutting High Cost of Living

Bread Price Drops

TODAY

the price of our 24-ounce loaf of bread

REDUCED TO 12 CTS.

This is the lowest retail price that has been named to housewives in any city in the country and is made possible by the decline in the flour market.

A WORD ABOUT OUR BAKERY

Until recently we were baking bread by the use of gas, but heeding the warning by the East Ohio Gas Co. of an impending shortage of natural gas, we entered into contract with The Westinghouse Electric & Mfg. Co. for the installation of an electric heating equipment. The results have exceeded our expectations, as the bread is uniformly and thoroughly baked, due to the absolute control of the heat.

Our bakery is the only large plant in the United States entirely operated by electricity and is the last word in efficiency.

You can eat the bread and feed it to your children with absolute confidence that it is produced under the most exacting sanitary conditions.

The Fisher Bros. Co.

AN INTERESTING announcement a few days ago by a prominent bakery in Cleveland, Ohio, shows how efficiency due to electricity is helping to bring down the price of bread.

Digest of Electrical Literature

Including Brief Abstracts of and References to Important Articles Appearing in the Scientific and Engineering Press of the World

Motors, Generators and Transformers

Design of Flywheels for Reciprocating Machinery Connected to Synchronous Generators or Motors.—R. E. DOHERTY and R. F. FRANKLIN.—The authors assert that this problem has long been a matter of cut and try and has not been fully worked out theoretically. The purpose of this paper is to provide means for the calculation, with practical accuracy and expedition, of flywheels for reciprocating machinery connected to synchronous generators or motors.—Paper presented before the A. S. M. E. convention, Dec. 7, 1920.

Lamps and Lighting

Report of I. E. S. Committee on Progress.—The committee deals with all phases of lighting and illumination, covering some developments from foreign countries during the last year.—Report made at the I. E. S. convention, Oct. 18, 1920.

The Cooper Hewitt Quartz Lamp and Ultra-Violet Light.—L. J. BUTTOLPH.—It is said that the Cooper Hewitt quartz burner operates at a much higher temperature and hence at greater intrinsic brilliancy than the ordinary mercury-vapor lamp, and it is peculiarly rich in violet and ultra-violet radiation. These ultra-violet rays are screened out by ordinary crown glass, but are transmitted freely by quartz. The quartz lamp is of value in research work, and commercially is of great importance in photographic and photochemical processes and in the treatment of parasitic and tubercular skin affections. Its therapeutic effects are similar to those of X-rays, but are less severe.—*General Electric Review*, November, 1920.

Generation, Transmission and Distribution

Notes on Electrical Calculations of Long-Distance High-Voltage Transmission Lines.—A. MCKINSTRY.—An extensive comparison of the various accurate methods for calculating voltage regulation and other characteristics of long-distance lines, including an extensive set of tables for determining the constants of the lines.—*Journal of Institution of Electrical Engineers*, London, October, 1920.

The Hydro-Electric Plant at Eget, France.—EYDOUX and LEBOUCHER.—The 35,000-hp. plant at Eget, in the Pyrenees, is remarkable because of its elaborate hydraulic construction. The extremely uneven run-off of the many little streams draining from the Lannemezan plateau makes a rational utilization of the water power very difficult. However, by building some large dams several natural lakes have been turned into an equal number of reservoirs, among them three of about 7,000,000 cu.m. (250,000,000 cu.ft.) capacity each, and a continuous all-year supply of 11 cu.m. to 13 cu.m. per second (390 to 460 sec.-ft.) has thus been safeguarded. Two of the reservoirs are interconnected by a channel of 3,100 m. (10,000 ft.) length and with a capacity of 3 cu.m. per second (105 sec.-ft.). This channel is entirely subterranean except where it crosses a chasm on a 39-m. (128-ft.) aqueduct. The water then is conducted to a small subterranean reservoir just above the generating plant, through another underground conduit, capable of carrying the whole water supply, and blasted 5,600 m. (17,700 ft.) through solid rock. The turbines are fed through seven closed-tube conduits. Seven 500-r.p.m. Pelton turbines of 5,000 hp. each are installed and work at a net head of 740 m. (243 ft.). Owing to the great head extreme care has to be taken to avoid dangerous water hammer in the tubes, and the turbines therefore are provided with a special type of highly damped governors. In each unit the generator is directly coupled to its turbine, and between them there is a 3,500-kg. (7,700-lb.) flywheel to smooth out the motion and keep sudden load variations away from the hydraulic system. The generators deliver 3,500 kw. each, at 50 cycles, 6,000 volts, and a power factor of 0.8. To facilitate repair work the stator is arranged so that it can be slid sideways till the rotor becomes entirely free for inspection. The generators are connected to two groups of 4,375-kva., single-phase transformers, with a ratio of 6,000/69,284 volts. The transformer windings are temporarily connected in delta on the high-tension side, but eventually will be changed to star connection, giving a transmission voltage of 120,000 volts. Relay-operated circuit breakers of a breaking capacity of 70,000 kva. are installed on the 6,000-volt side, and 120,000 volt electrolytic aluminum-cell protectors are part of the equipment. The plant and its construction are described in great detail in a most comprehensive and well illustrated article.—*Révue Générale de l'Electricité*, July 3, 10, 17 and 24, 1920.

Piling Storage Coal to Prevent Fire.—W. D. LANGTRY.—More care should be exercised in the storage of coal with respect to origin and size, the choosing of a suitable storage place, avoidance of breakage in unloading, segregation of different sizes, outside sources of heat and the mixing of combustible matter with the coal. The author advises against pyramiding the coal, but says it should be piled in layers as shallow as the available space will permit.—*Power*, Nov. 23, 1920.

Traction

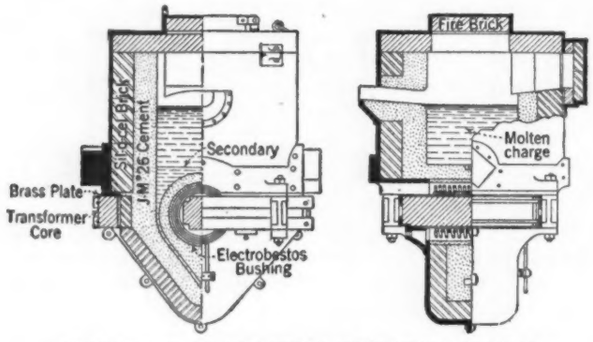
Electric Locomotives for the Austrian Railroads.—Two types of electric locomotives have recently been ordered by the Austrian government to be used on certain state railroads now being electrified. The power supply is 15,000-volt, single-phase alternating current of $16\frac{2}{3}$ cycles. The first type is a 1C + C1 locomotive for pulling heavy express trains over steep grades. It is provided with two single-phase double motors geared in a ratio of one to three to a counter-shaft which actuates the drive wheels by cranks and connecting rods. The motors are rated continuously at 370 kw. with a one-hour rating of 460 kw. at 575 volts. They are supplied from a 2,000-kva., 15,000/1,240-volt trans-

former with a number of taps in the secondary for speed control. This type of locomotive weighs about 116 tons. The other type is also intended for express service in mountain districts, but has a weight of only 69 tons and is of the 1C1 type. The latter type has the same kind of drive, but a gear ratio of 1: 4.24. Each locomotive is provided with two motors of 290 kw. continuous and 410 kw. one-hour rating, with interpoles shunted by resistances.—*Elektrische Kraftbetriebe und Bahnen*, Oct. 24, 1920 (also *Elektrotechnik und Maschinenbau*, May 2 and Oct. 31, 1920).

The Magdeburg-Leipsic-Halle Electrification.—HEYDEN.—This road is supplied from a steam plant which is described in the article. The plant is equipped with six single-phase turbo-generator units delivering 3,300 kw. each at 3,300 volts. The armature slots in the generators are closed by massive copper bars. These bars are interconnected at either end of the machine by heavy bronze disks so as to form a big squirrel-cage winding which very effectively damps out pulsations of the magnetic fields. This damper winding prevents dangerous voltages from being induced in the rotor winding by short-circuits and sudden load variations. The power is transmitted to the secondary stations at 60,000 volts, and the author also describes a set of sturdy 1,875-kva. transformers used for stepping up the voltage.—*Elektrische Kraftbetriebe und Bahnen*, June 14 and Aug. 14, 1920.

Installations, Systems and Appliances

The Electric Melting Furnace.—A symposium in which the early history of the electric furnace is discussed by Prof. Joseph W. Richards, and the development of the Greaves-Etchells furnace by F. W. Brooks, the Moore "Rapid Lectromelt" furnace by R. D. Thomas, the Weeks electric furnace by F. H. Auerbacher and the Ajax-Wyatt electric furnace by G. H. Clamer. Recent



SECTIONS OF AN INDUCTION TYPE BRASS FURNACE

developments and chief characteristic of each of these makes of electric furnace are treated. Sections showing the circuit arrangement and heat insulation used in an Ajax-Wyatt furnace are reproduced.—*Journal A. I. E. E.*, December, 1920.

Electrostatic Condensers.—V. E. GOODWIN.—The writer discusses the subject in broad manner, dealing with the fundamental characteristics of condensers and their relations to electric circuits containing inductance and resistance. He also includes a discussion of the effects of switching condensers on and off such circuits. He then describes some of the more important applications of condensers and illustrates the great demand there is in the electrical industry for this class of apparatus.—*Journal A. I. E. E.*, November, 1920.

Electrophysics and Magnetism

Ionization and Resonance Potentials of Some Non-Metallic Elements.—F. L. MOHLER and PAUL D. FOOTE.—The resonance and ionization potentials of phosphorus, iodine, sulphur, nitrogen, oxygen and hydrogen have been measured in four-electrode vacuum tubes by methods similar to those used previously by the authors. The results with hydrogen agree with the theoretical predictions of Bohr.—*Scientific Paper No. 400*, Oct. 14, 1920.

Sparking Voltages Between Spherical Electrodes.—ALEXANDER RUSSELL.—A theoretical study of the matter with experimental results which confirm the author's calculations. It is asserted that some commonly accepted values for sphere gaps are in error.—*Journal of Institute of Electrical Engineers*, London, October, 1920.

Electrochemistry and Batteries

Electric Versus Combustion Furnaces for Low Temperatures.—Electric furnaces have the advantages over other furnaces of temperature control, a reliable and permanent source of heat and lower maintenance cost. The greater cost of energy, on the other hand, is counterbalanced by economy in space, auxiliary equipment and operation, while the quality of the product is greatly enhanced.—*Chemical and Metallurgical Engineering*, Nov. 24, 1920.

Units, Measurements and Instruments

Multohm Resistance Units.—LILIENFELD and HOFMANN.—This is a new type of resistance unit for very high-resistance values, namely, from 0.1 megohm to about 10 megohms. The unit consists of a glass tube, closed at both ends and provided on the inside with a thin layer of carbon, usually running in a spiral from one end of the tube to the other. These resistances are said to be remarkably constant from one day to another, but they have a rather high temperature coefficient—0.0016 per degree Centigrade. The tubes have a diameter of 10.5 mm. (0.41 in.) and come in two sizes, 20 cm. and 54 cm. long (8 in. and 21 in.). These units stand respectively about 40 and 115 watts continuously in air and about three times as much in oil. Another type of resistance unit with a small temperature coefficient has also been devised, where the conducting layer is made of a mixture of metal oxides instead of carbon.—*Elektrotechnische Zeitschrift*, Nov. 4, 1920.

Telegraphy, Telephony and Signals

High-Tension Direct-Current Machinery for Radio Spark Stations.—ROGOWSKI.—A detailed analysis of the operating conditions of a high-tension direct-current generator when used to energize an antenna by means of a rotating spark gap. The machine is subjected to severe strains due to overvoltages caused by resonance phenomena, electric surges in the winding, etc. On the basis of analytical considerations the author explains certain severe breakdowns in a German radio station which occurred in a 5,000-volt double-commutator machine.—*Archiv für Elektrotechnik*, Sept. 20, 1920.

Status of Static Frequency Doubler in Radio Engineering Practice.—FREDERICK C. RYAN.—The system of sustaining wave generation based on the use of a radio or high-audio-frequency alternator and frequency multipliers is considered. Expressions for the secondary voltages of the unloaded ferromagnetic doubler of the polarized-core type are derived and explained.—*Proceedings Institute of Radio Engineers*, December, 1920.

News of the Industry

Chronicle of Important Events and General Activities in the Technical, Commercial and Manufacturing Fields With Announcements and Reports of Association Meetings and Conventions

Pupin This Year's Edison Medalist

ANNOUNCEMENT is made this week by the American Institute of Electrical Engineers of the 1920 award of the Edison medal to Dr. M. I. Pupin "for work in mathematical physics and its application to the electrical transmission of intelligence." The medal will be presented to Dr. Pupin Friday evening, Feb. 18, at a session of the midwinter convention of the Institute in New York.

Dr. Pupin is probably best known for the invention of the loading coil for telephone transmission. Of late years he has been devoting considerable attention to the study of wireless phenomena, and he has already made a number of contributions to the science of radio.

Utility Not Justified in Asking Customer to Finance Service Connections

THAT an electric light and power company "is not justified in demanding that a prospective consumer supply capital for the labor and material required to make a service connection" was held by the Public Service Commission of Pennsylvania last week in sustaining the complaint of Elias Lovell of Ashland against the Eastern Pennsylvania Light, Heat & Power Company's rule requiring a deposit of $25 before installing service.

The commission says it is "clearly a demand on the part of the company requiring the prospective consumer to finance a service connection." The service line of an electric company to the point of connection just outside the building of the consumer should be the property of and installed by the company at its expense, the decision says.

Milwaukee Power Restrictions Removed on Opening of New Plant

RESTRICTIONS on the use of power were removed in Milwaukee on Thursday, Dec. 23, when the new pulverized-coal-fired Lakeside power plant was formally placed in service. One 20,000-kva. generating unit is in operation, and the second unit is expected to be ready during the coming March. The first section of the plant now being completed consists of two turbo-generators supplied with steam from eight 1,306-hp. boilers operating at 300-lb. pressure with 200 deg. superheat. The superheaters are being placed immediately above the boiler tubes, and the economizers are mounted to one side against the boiler-room walls. The coal pulverizing and drying section contains eight pulverizers with a capacity of 6 tons per hour each. Provision has been made for storing 100,000 tons of coal in piles on the ground, 2,000 tons in cars and 3,500 tons in bunkers. Condenser water is taken from a circulating-water pond constructed at the lake through a 10-ft. tunnel designed to provide circulating water for an ultimate capacity of 200,000 kw. Ground was broken for the plant on Feb. 18, 1920, and the first unit therefore goes into service in a little more than ten months from the beginning of construction.

String of Hydro-Electric Plants Planned for Indiana on Tippecanoe

NEW YORK and Chicago financiers and several citizens of Indiana are planning to begin work in the spring on a number of dams and power units along the Tippecanoe River to develop electricity for several of the larger towns in northern Indiana. The plans, it is reported, call for the incorporation of the Tippecanoe Power Company with a capital stock of $3,000,000, which will be closely held. Contracts, it is claimed, already have been made for the entire output of energy. Among the others interested in the project are John A. Shafer of Indianapolis, an engineer, who has surveyed the project and prepared preliminary plans; Samuel Thompson, Mayor of Monticello, and Curtis J. Meeker of Monticello.

This first unit is expected to develop 20,000 hp. It is planned ultimately to build six other units of the same size on the Tippecanoe River. The corporation plans to build other dams near the mouth of the river, near Springboro, at Oakdale, Tioga, Norway, Buffalo, Pulaski and near Winamac. It also plans to direct much of the surplus water of the Kankakee through the Yellow River to the Tippecanoe River.

Application to Develop 2,500,000 Hp. on Colorado River

APPLICATION has been made to the Federal Power Commission by the Southern California Edison Company to develop 2,500,000 hp. on the lower Colorado River. The preliminary plans contemplate projects above Boulder Canyon at Marble Canyon and Diamond Creek.

The total possible development on the Colorado River is estimated at 4,000,000 hp., including sites along the Grand Canyon. The river has an annual run-off of 16,000,000 acre-ft. and drains an area of 250,000 square miles, a large part of which is in the higher reaches of the Rocky Mountains. Because of the inaccessibility of some of the power sites it has been proposed to construct first the one farthest downstream, which is that most easily available, and upon its completion to float the material for the next station above on the reservoir created by the lower dam.

The stations will probably be built for operation with heads not exceeding 500 ft. and will be without canal lines. Reference to this development and the utilization of the energy from it was made in the ELECTRICAL WORLD for Oct. 4, 1919, page 743.

Water-Power Applications Now in Excess of 10,000,000 Hp.

APPLICATIONS for preliminary permits or licenses under the water-power act now cover more than 10,000,000 hp. The horsepower which can be developed by the Southern California Edison Company's Colorado River project is estimated roughly at 3,500,000 hp. If that figure could be carried into the total the aggregate of horsepower covered by all applications would be in excess of 12,000,000. Even if the estimate on that project were scaled down 2,000,000 hp. the total still would be in excess of 10,000,000 hp.

The proposed development on the Colorado River is regarded as doubly important because of the fact that it is contemplated to store the entire flood-water flow of that river, thus giving relief to the Imperial Valley.

New Jersey Court Sustains Ousting of Utilities Commission

THE action of Governor Edwards of New Jersey in dismissing the four members of the Board of Public Utility Commissioners, charging them with neglect of duty, misconduct in office and favoritism to the corporate interests of the state, has been sustained by the Supreme Court of New Jersey. It is probable that the four commissioners will take an appeal to the Court of Errors and Appeals as the action of the Supreme Court sustained only the right of the Governor to remove the commissioners for cause and did not sustain the charges against the members of the board.

Governor Edwards has issued a call for a special session of the Senate this week to confirm members of a new board. When he dismissed the commissioners in October the New Jersey Senate refused to confirm his appointments on the ground that there was grave legal doubt as to his power to oust the board. In political circles in New Jersey it is rumored that the Senate will again refuse to confirm the new appointments pending an appeal by the four commissioners.

Steam Coal Prices in Heavy Decline

THE coal market is "saturated," declared an official of one of the large Middle Western coal sales companies last week. The poorer grades of steam coal have dropped from $2 to 83 cents a ton in the Central West, while the better grades that have sold at from $7 to $8 are now going begging at from $3.50 to $4. In some cases coal that sold at from $8 to $10 a few months ago is now going at $3 per ton.

"There is a greater supply than demand," said George W. Reed, vice-president of the Peabody Coal Company, in a public statement last week. "Industries have shut down all over the country. They have no further use for fuel. Conditions are beginning to readjust themselves. I would say that the drop in the price of coal is simply an indication of business getting down to normal competitive prices."

The high reconsigning and demurrage charges are having an effect in preventing the shipping of coal except to supply direct orders. Several operators at a meeting of the Illinois Coal Operators' Association in Chicago last week declared that coal is being piled up at the mines, where full production is in progress without purchasers. The indications in the entire Middle Western territory are that the wild speculation is past.

California Co-operative Campaign Emphasizes One Thing Each Month

A PROGRAM for field representatives of the California Co-operative Campaign has been outlined for 1921 in which special emphasis will be given each month to one subject. During 1921 the field men will continue the same lines of work but will give special attention to a single, particular phase of this work during each month of the year. This special effort will be to present the subject chosen for each month to meetings of the electrical industry in all localities throughout the state. Each subject will be presented in an address by a representative of the campaign, followed by discussion and such action as local conditions justify.

The following tentative program of subjects for the first six months of 1921 has been arranged: January, industrial and commercial lighting; February, convenient outlets; March, contractor-dealer accounting; April, financing hydro-electric development through self-interest; May, salesmanship and service to the public; June, responsibility to the industry.

December Financing Brings Year's Reported Total Up to $316,373,000

THE December financing of public utilities, so far as electric light and power companies are concerned, added $34,384,000 to the year's total, making $316,373,000 reported. There are two ten-million-dollar issues, both of which are to run for twenty years. One of these, offered by the Pacific Gas & Electric Company of San Francisco, yields 7.10 per cent; the other being 8 per cent interest and was sold by the Kansas City Power & Light Company at par. The Middle West Utilities Company offered $2,134,000 in twenty-year secured gold notes at 95.25, to yield 8.5 per cent—the highest yield that a security having as long as twenty years to run has carried. The accompanying table has an additional column this month giving, whenever the information was available, the "purpose of the issue."

Name of Company	Amount of Issue	Period	Class of Security	Purpose of the Issue	Rate of Interest	Per Cent Yield	Offered at
Metropolitan Edison Co	$1,000,000	15-year	Refunding and improvement mortgage gold bonds	Refunding and new construction	8	8.5	95.82
Brooklyn Edison Co., Inc	5,000,000	20-year	General mortgage gold bonds	New construction	7	7.25	97½
Pacific Gas & Electric Co	10,000,000	20-year	First and refunding mortgage gold bonds	Refunding and new construction	7	7.10	99
Consolidated Gas, Electric Light & Power Co. of Baltimore	5,000,000	25-year	First and refunding mortgage sinking-fund gold bonds	Refunding and new construction	7 5	7.75	97.25
Kansas City Power & Light Co	10,000,000	20-year	First and refunding gold bonds		8	8	100
Consolidated Utilities Co	250,000	5-year	Collateral trust note	New construction	8	...	...
Puget Sound Power & Light Co	1,000,000	5-year	Gold coupon notes	New construction	8	8	Par
Middle West Utilities Co	2,134,000	20-year	Secured gold notes	....	8	8.5	95.25
Total	$34,384,000						

Niagara Power Applications to Be Heard January 24

THE various applications for water-power rights on the Niagara River will be the subject of a hearing before the Federal Power Commission on Jan. 24. This date was set by the commission at its regular meeting Dec. 27. The hearing will be conducted in the building of the Interior Department in Washington.

Higher Rates Wait on Improved Service

AN APPLICATION of the Wisconsin Traction, Light, Heat & Power Company for increased rates at Neenah, Wis., was denied recently by the Wisconsin Railroad Commission. No further consideration will be given to demands for increased rates, the commission told the company, until "it shall have been shown to the satisfaction of the commission that substantial progress is being made in the rendering of service and good faith shown. This decision is in line with one by the Illinois commission reported in the ELECTRICAL WORLD for Dec. 18 (page 1228).

Basic Rates for Government Electrical Workers

IN THE revised reclassification bill which a Congressional committee has now under preparation it is understood that the following basic rates have been agreed upon for electrical workers in the government service: Electrician, $1 an hour; foreman electrician, $2,340 per annum; dynamo tender, $1,380 to $1,500; electric substation operator, $1,680; assistant electric substation operator, $1,200 to $1,300; electric switchboard operator, $1,680.

Great Falls Development Reported Favorably

A FAVORABLE report as to the feasibility of utilizing Great Falls, on the Potomac, near Washington, D. C., for power purposes, was submitted to Congress Dec. 27. Gen. Lansing H. Beach, the chief of engineers, in his letter of transmittal, said:

"Major Max Tyler has reached the conclusion that a power development of from 45,000 kw. to 50,000 kw. is possible and that its costs will be such as to permit the delivery of intermittent power at a total cost, including all proper overhead and transmission charges, of about 5 mills per horsepower at substations in the city of Washington at a voltage of 6,600. This estimate includes the cost of the high-tension transmission line and of three local substations. Storage possibilities were found not to be very favorable unless an ultimate development of a total head of about 200 ft. is decided upon as desirable, thereby permitting the storage to be used twice, once in each stage of the development."

Owing to the illness of Major Tyler it was impossible to submit the entire report, but it is understood that the plan which will be recommended favors the continued operation of the large steam plant which is the present source of power for the District of Columbia and its vicinity.

On hearing that the engineers again have reported favorably on the development of water power at Great Falls, Senator Norris of Nebraska announced that he would press for consideration a bill providing for the early development of this water power. He favors government ownership of the plant which it will be necessary to erect. This is advisable, he believes, since the government is one of the large district's consumers of electric power in the District of Columbia.

President Edgar Receives Birthday Surprise

CHARLES L. EDGAR

CHARLES L. EDGAR, president of the Edison Electric Illuminating Company of Boston, was surprised by the 2,300 employees of the company last week, on the occasion of his sixtieth birthday anniversary, when a committee of fourteen, headed by I. E. Moultrop, presented him with a gold wrist watch suitably engraved, a set of sapphire and gold cuff links and an illuminated parchment expressing the great esteem in which he is held by those in the service of the organization. The women employees of the company gave the cuff links, and all shared in the other gifts. The parchment expressed the employees' gratitude that so many years of Mr. Edgar's life have been devoted to the development of the company and the wish that there may be many more of pleasant relations and even greater successes.

Referendum on Home Rule for Chicago

HOME rule for Chicago carried as far as Chicago itself will accept on a popular referendum vote is the latest version of the Illinois utilities commission situation. It is expected that Governor-elect Small will insist in his inaugural upon legislative action that will let Chicago at least establish a local transportation district. Mr. Small's campaign included among its chief policies the abolition of the present utilities commission and a return to home rule for the entire state. It has been expected in many quarters that the issue would simmer down to either home rule for Chicago or a separate commission to handle Chicago utility problems.

Standby Fuel Clause Established by Montpelier Company

THE Montpelier & Barre (Vt.) Light & Power Company, a Tenney property, has filed a fuel clause with the Vermont Public Service Commission providing that whenever during any month or part thereof in which power service is furnished by the company under its Schedule E it shall be necessary for the company to operate its steam generating stations to supply this power service, in whole or in part, then, in addition to the prices named in the schedule, there will be made and become payable a charge per kilowatt-hour obtained by dividing the cost of fuel at the generating station by the kilowatt-hours sold for power purposes. All additional charges to the customer due to the foregoing terms are to be made at the time the regular monthly bill is rendered and to be included as a part of the regular bill. Such charges are based upon the cost of fuel and the kilowatt-hours sold for power purposes during the calendar month immediately preceding the date of the bill.

Group Buying of Coal Suggested for German Utilities

IN OPPOSITION to the proposal for nationalization of the coal mines of Germany comes a counter-proposal from the German "coal king" Stinnes for co-operative combinations of large consumers of coal, such as electric light and power companies, gas plants, manufacturing plants and others, and for a corresponding number of coal mines sufficient for their supply. Each of these groups, it is proposed, shall have a board to regulate prices and distribution, and in these boards the consumers shall have the majority. It is further suggested that such consumer groups should gradually buy up the control of the coal mines.

University Extension Course for Metermen

A SHORT intensive course for electric metermen has been announced by the College of Engineering and the extension division of the University of Wisconsin, Madison, Wis., in co-operation with the Railroad Commission of Wisconsin and the Wisconsin Electrical Association. This course will be held at the engineering college laboratory from Jan. 31 to Feb. 4, 1921. The work will be adapted to the needs of the men and will be conducted by lectures and a graded series of tests or tasks. A fee of $10 will be charged each student to pay for power, supplies, and other incidental expenses.

Mexico to Develop a 100,000 Hp. Hydro-Electric Project

THE Government of the State of San Luis Potosi, Mexico, has just awarded to E. E. Thomas of Tampico a contract for the construction of a dam and water storage reservoir in the Rio Verde Valley to develop 100,000 hp. for hydro-electric and irrigation purposes. It is said that the dam will cost approximately $2,000,000 American money. Engineers are now making a survey. According to Mr. Thomas, actual construction work will start about Jan. 1, and it is expected that the work will be completed within two years.

The contract is the first of its kind to be given out since the beginning of the revolution ten years ago and the second that the State of San Luis Potosi has awarded in its history. All of the work will be under the supervision of American engineers.

San Francisco Electrical Development League Sells Utility Stock

THE Electrical Development League of San Francisco has recently organized a committee which is canvassing all the members of the electrical industry in the central portion of California to solicit subscriptions to the securities of the local power companies. The results of the first two weeks' work show 146 subscribers and total sales of 363 shares of stock. Stocks of the Pacific Gas & Electric Company, the Great Western Power Company and the San Joaquin Light & Power Company are sold.

Although the total amount of capital obtained in this way may not be great, the backing of the entire industry as well as of the general public is considered vital to the success of the tremendous programs of power development now under way and contemplated in California. In organizing its work the committee, headed by W. S. Berry, Western Electric Company, took into consideration the principles outlined by W. H. Hodge in his article on "Customer Ownership of Securities" in the ELECTRICAL WORLD for Nov. 20, 1920, page 1018. Plans are being made to undertake a similar stock-selling campaign in southern California.

New York State Water-Power Legislation Coming Up

ONE of the more important functions that the incoming New York State Legislature of 1921 will be called upon to perform is the repassage of the Ferris amendment to the constitution. This amendment has to do with the development by the state and by corporations of the water powers within the state and with their regulation when developed. The amendment to the constitution was passed by the Legislature of 1920, but in order to be voted on by the people at the next general election it must be repassed by the Legislature of 1921. The Ferris amendment is designed to provide an ultimate system of development of all of the state's water powers, to insure the encouragement by the state of their development, to promote the more general use of electricity in commerce and transportation as well as in heating and lighting, and to reduce the cost of production of electrical energy to a minimum.

Electrical Safety to Be Keynote of Western Inspectors' Meeting

CENTRAL-STATION men, manufacturers and other non-members of the Western Association of Electrical Inspectors have been invited to contribute to the sixteenth annual convention of the association, which will be held at the Hotel Statler, Detroit, on Jan. 25, 26, 27 and 28. The principal subjects to be brought up for discussion are the safe use of primary service on customers' premises, the grounding of electric circuits and apparatus, safeguarding electric fixtures, and ways and means of improving old and defective wiring installations. The tentative program prepared by Secretary W. S. Boyd, Chicago, is as follows:

TUESDAY, JAN. 25

Morning Session. — Reports of officers and committees; illustrated address, "The Electric Furnace," by Edwin L. Crosby, Detroit Electric Furnace Company; "The Location, Construction and Equipment of Transformer Vaults," by Hubert J. Clark, engineer Oklahoma Inspection Bureau (discussion to be led by Lee Granger, assistant superintendent overhead lines Detroit Edison Company); "The Underwriters' Laboratories," by George B. Muldaur, general agent Underwriters' Laboratories, Chicago; "Regulating Motion-Picture Theaters," by Washington Devereux, chief electrical inspector Philadelphia Fire Underwriters' Association.

Afternoon Session.—General subject, "Grounding of Electric Circuits and Apparatus": (a) "The History of the Grounding of Secondaries," by F. A. Barron, General Electric Company; (b) "The Central Station's Responsibility" (speaker to be announced later); (c) "The Electrical Contractor's Responsibility," by Emil Anderson, Standard Electric Company, Minneapolis; (d) "Municipal Co-operation," by Gerald J. Wagner, director of public service, Grand Rapids, Mich.; (e) "Grounding Rules" (speaker to be announced later). General subject, "Safeguarding Electric Fixtures": (a) "Manufacturing and Shipping Problems," by C. H. Hofrichter, secretary National Council of Lighting Fixture Manufacturers; (b) "Factory Inspection Problems," by Dana Pierce, vice-president Underwriters' Laboratories, New York; (c) "Installation Problems," by J. L. Wolf, secretary Lighting Fixture Dealers' Association of America, Detroit; (d) "Inspection Problems," by Victor

H. Tousley, chief electrical inspector, Chicago. "Inductive Interference with Signal Circuits," by W. J. Canada, director of engineering, N. E. L. A.

WEDNESDAY, JAN. 26

Morning Session. — "Effect of Electrical Inspection and Municipal Fire-Alarm Systems on Fire Insurance Rates," by F. A. Raymond, National Board of Fire Underwriters, New York; general subject, "Improving Old and Defective Wiring Installations": (a) "The Municipal Inspector's Method," by Ben W. Clark, chief electrical inspector, Detroit; (b) "The Underwriters' Inspector's Method," by F. G. Waldenfels, chief electrical inspector Chicago Board of Underwriters; (c) "Central-Station Co-operation," by L. D. Smith, general superintendent Minneapolis General Electric Company.

Afternoon Session.—"Electric Welding of Traction Rails," by H. M. Gould, electrical engineer Street Railway Commission, Detroit; discussion of inspectors' problems previously submitted to the secretary in writing.

New business reports of special committees, report of the nominating committee and the election of officers take place on Thursday, Jan. 27, and Friday, Jan. 28, is to be given over to inspection trips in and around Detroit.

Kansas City Plans Educational Electrical Show

AN ELECTRIC show that will be educational rather than spectacular is the aim of the executive committee of the Electrical Trades Exposition Company, which will conduct Kansas City's show next March. Exhibitors are to be required either to illustrate the development of the use of electric power or to educate those interested as to the reasons for results obtained from the processes on exhibition. A model electrical home is being arranged for, and the domestic science department of the public schools will conduct electric cooking demonstrations. A lighting plan that will demonstrate what can be accomplished by properly worked-out illumination schemes is also planned.

Government Engineers' Salary Bill Provisions

THE bill providing for the classification of salaries for civilian positions in the government service fixes the rate of pay at from $1,800 to $2,160 for all junior engineers, who are "to perform under immediate supervision the simplest kinds of work in engineering requiring professional training." The salary rates of the next group are from $2,340 to $2,880. Assistant engineers coming in that group are "to perform under general direction assigned work in engineering requiring professional training and previous experience, but not the exercise of independent judgment."

The range of annual compensation in the next engineer group is from $3,120 to $3,840. Engineers falling in that group are "to perform independently or with a small number of subordinates responsible professional work in engineering requiring extended training and considerable previous experience."

In the next grade the range of compensation is from $4,140 to $5,040. Those falling in that group are known as senior engineers, who are "to perform independent and highly expert work in engineering or to be responsible for the administration of a minor division of a large or a major division of a small engineering organization."

The salary in the next group is $5,400 and up. Those falling in that group are known as principal engineers, who are "to act as head of the major division of a large engineering organization, or as assistant head of a large engineering organization, or as head of a small engineering organization, or to serve as consulting specialist on the most important engineering plans, or to carry on the most advanced engineering research."

In the next group the annual compensation is to be $6,000 and up. The group covers those qualified to act as technical and administrative heads of a major engineering bureau or organization.

Vermont's New Engineer Governor Takes Office

VERMONT'S new state administration takes office in January. It will be headed by an engineer of national reputation, James Hartness, former president of the American Society of Mechanical Engineers, machine tool builder and inventor, amateur astronomer and aviator, and fellow of the American Association for the Advancement of Science.

Water Study Important in Large Steam-Plant Development

THE use of water in the operation of steam plants as a factor in any study of the water resources of a state was stressed by N. C. Grover, chief hydraulic engineer for the United States Geological Survey, in an address before the Kansas Engineering Society of Topeka on Thursday, Dec. 16. Mr. Grover pointed out that for each ton of coal used in a modern steam plant approximately 800 tons of water is required, and that in any locality depending on steam power the availability of water for such use will determine industrial development. The abundant supply of coal in various sections of the United States was discussed, but Mr. Grover warned the engineers that the supply from the thick veins of the Eastern fields would be exhausted in from one to two generations. Industry must then turn to poorer grades that will be mined at higher costs. The available water supplies in the Middle Western States will thus become a more important factor, as on this supply and its location will depend the possibility of establishing large plants that can produce power at an economical figure. The speaker urged that every study of water resources include the use of the supply for power production purposes and indicated his belief that as the cheaper fuel supplies of the East were exhausted a migration of industries closer to the fuel supplies of the West and Middle West would occur.

The committee on electrical engineering presented a report in which closer co-operation of the electrical engineers with the Kansas Engineering Society was urged, particularly in view of the study of water resources now being undertaken by the state. In this study all engineers are interested, the electrical engineers in utility work being especially concerned from the standpoint of future power supply.

Current News and Notes

Timely items on electrical happenings throughout the world, together with brief notes of general interest.

Emergency Central-Station Service Helps Out Municipal Plants.—The city of Idaho Falls, Idaho, faced a serious situation recently when the freezing of Snake River caused a complete tie-up of the municipal power and pumping plants, cutting off the city's water supply and depriving it of fire protection. Faced with grave danger, the city sought and obtained emergency service from the Utah Power & Light Company's lines, and in a few hours the plants were again in operation.

Accidents and Electricity.—Although Wisconsin's record of accidental death and disability in 1919 was the worst in the history of the state, it is interesting to note the small part that electricity played as a cause. Out of a total of 14,995 casualties only 75 were attributed to electricity, and out of 2,870,803 days lost through accidents only 82,395 were chargeable to electrical accidents. Electricity brought up the rear in the list, with one-half of 1 per cent of the total casualties in the state.

A Long-Distance Concert.—Recently Louisa Tetrazzini, the grand opera prima donna, standing in her apartment in a New York hotel, sang four songs into a specially equipped telephone, tuned to transpose her voice to the telephonic receiving sets with which nearly all of the vessels of the United States Navy are now equipped. Amplifiers on board all ships of the navy at sea and in port within a radius of 400 miles had been rigged to project Tetrazzini's voice on shipboard. The crews were assembled at the hour set for the concert, and telephonic radio stations were ordered to suspend traffic for thirty minutes. The concert was officially reported a success.

Water Shortage and Oil Supply in California.—A record use of oil in 1920 in the manufacture of electrical energy is reported by the Railroad Commission of California. Steam-made electricity necessitated by the water shortage was responsible for an enormous increase in oil consumption, the commission estimating the total figures for the year's use by utilities selling gas and electricity at about 6,000,000 bbl., or 1,000,000 bbl. more than is used in normal years. Increase in the price of oil ranged from 70 cents a barrel to $2, varying according to location. A material reduction in the use of oil, however, is expected by the commission as a result of hydro-electric developments under way and in prospect.

Extensive Icelandic Program of Water-Power Development.—Magnus Gudmandsson, the Finance Minister of Iceland, has arrived at Copenhagen to obtain the consent of the Danish government to an act for the development of the copious water powers of the frozen island. An extensive program of hydro-electric development is favored by the Icelanders, but the capital for it must be raised elsewhere.

Wireless Telephony as a Police Aid.—The use of the wireless telephone as an aid in the prevention and detection of crime is being tested by the Police Department of St. Louis. A sending outfit with a range of 40 miles has been installed at the police headquarters and three automobiles have been equipped with receiving apparatus. By this means it is possible to change the orders of a squad while it is at work. One man in each automobile has the receiver strapped to his head at all times. If, for instance, a squad were sent out on a false clew and correct information reached headquarters after the men had left, it would be possible to stop the wild-goose chase and give the squad the proper orders.

Detroit Edison's New Service Building.—The ten-story service building of the Detroit Edison Company is nearing completion and will, the house organ of that company announces, be ready for occupancy early in 1921. It occupies a whole block at 2030 Second Avenue and is ten stories in height. The sales department will be on the first floor, the accounting department, laboratory, meter-testing department and various other departments on the second, third and fourth floors, and the executive offices on the fifth. The next three floors will house the construction engineering offices, drafting rooms, "trouble board" and so forth. On the ninth floor there will be an auditorium, a cafeteria and kitchen and women's rest rooms, and on the tenth a men's lobby, a classroom and private dining rooms.

Newfoundland as a Field for Hydro-Electricity.—The ancient British colony of Newfoundland has virtually no rural roads, and most of the inhabitants live on the coast. There is, however, an abundance of water power, and Lord Northcliffe, the English newspaper proprietor, has established large paper mills in the northeastern interior. An investigation by Canadian interests which hold options on power and pulp concessions on the south coast has recently led to a survey of the Bay d'Est River and the lakes tributary to it. These lakes, the surveyor reported, offer splendid facilities for water storage, as the level of some of them can be raised 25 ft. by inexpensive dams. From the lowest of the storage lakes to tidewater at the mouth of the river there is a fall of 500 ft., making possible the development of 75,000 hp. An industry capitalized at $10,000,000 will be established on the river if the plans now under consideration are carried out.

Associations and Societies

A complete Directory of Electrical Associations is printed in the first issue of each month.

Ohio Association Committee Meetings.—The new-business co-operations committee of the Ohio Electric Light Association is scheduled to meet at Cincinnati on Jan. 20, the transmission and distribution committee at Columbus on Jan. 20, and the meter committee at Cleveland on Jan. 21.

Electric Club of Chicago.—Officers of this club for the ensuing year were recently elected as follows: President, W. H. Colman; vice-president, A. G. de Clercq; second vice-president, E. F. Kirkpatrick; secretary-treasurer, E. E. Williams; three-year trustee, W. E. Bischoff; directors at large, T. J. Rider, Jr., and Harold Almert.

Mechanical Engineers' January Meetings.—Among the meetings of the A. S. M. E. to be held this month are one at Atlanta, on Jan. 25, when water-power development will be discussed by B. N. Hall of the Georgia Railway & Power Company, and one at Philadelphia on the same date, when Julian S. Simsohn will deal with water treatment for boilers.

Birmingham Section, A. I. and S. E. E.—The program arranged for the meeting of this section on Jan. 27 includes a paper on "Alternating Current in Byproduct Plants," by W. V. Dunn, chief electrician Tennessee Coal, Iron & Railroad Company, Fairfield, Ala., and one on "Direct Current in Byproduct Plants," by E. R. Winters, chief electrician Woodward Iron Company, Woodward, Ala.

Coming Meetings of Electrical and Other Technical Societies

Association of Iron and Steel Electrical Engineers—Philadelphia Section, Jan. 8; Cleveland Section, Jan. 10; Chicago Section, Jan. 15; Pittsburgh Section, Jan. 15; Birmingham Section, Jan. 27.

American Institute of Electrical Engineers—Akron-Cleveland, Jan. 14; Portland (Ore.) Section, Jan. 10; Boston Section, Jan. 11; Pittsfield Section, Jan. 20; Chicago Section, Jan. 24.

Wisconsin State Association of Electrical Contractors and Dealers—Milwaukee, Jan. 19 and 20.

American Washing Machine Association—Chicago, Jan. 19 and 20.

American Society of Civil Engineers—New York, Jan. 19.

Western Association of Electrical Inspectors—Detroit, Jan. 25-27.

Association of Municipal Electrical Utilities of Ontario—Toronto, Jan. 27 and 28.

A. I. E. E. (New York Section) and A. S. M. E. (Metropolitan Section) — New York, Jan. 28.

Florida Engineering Society—Lakeland, Fla., Feb. 7 and 8.

A. I. E. E.—Midwinter convention, New York, Feb. 16-18.

American Physical Society—New York, Feb. 25 and 26.

Commission Rulings

Important decisions of various state bodies involving or affecting electric light and power utilities

Electricity for X-Ray Machines.—Electric service for motors used in operating X-ray machines should, the North Dakota Board of Railroad Commissioners has declared, be classed as power service and should carry the power rate, including the regular minimum monthly service charge based upon horsepower of connected load.

Abolition of Surcharge.—The Arizona Corporation Commission has ordered the Tucson Gas, Electric Light & Power Company to discontinue its surcharge on minimum bills. The company was authorized to collect a surcharge by an order issued May 25, 1918; but the commission as the result of an investigation made on its own initiative held that changing conditions made this increase no longer warrantable where commercial lighting business or residence consumption does not exceed 8 kw.-hr. or where municipal power falls within the minimum designated in the company's rate schedule.

Different Departments of Utility Must Be Considered Separately.—The Colorado Public Utilities Commission has declared in passing upon an application from the Trinidad Electric Transmission Railway for permission to abandon certain service that the expenses and earnings of the street-railway department of a utility which operates also electric and gas departments must be considered separately even though the utility has received valuable franchises and street-lighting contracts upon the understanding that the car lines could not be operated at a profit for some time, and notwithstanding that the return to the company as a whole is reasonable.

Service and Minimum Charges.—A service charge is fairer and more equitable than a minimum charge, according to an opinion of the New York Public Service Commission, Second District, because under the minimum charge the less energy a consumer uses the more he pays for having the privilege of using the service whether he requires it or not, while under a service charge the cost of having the service available for use is borne equally by all consumers and not entirely by the small consumers, as is the result with a minimum charge. The commission refused to approve a minimum bill of $2.50 for private consumers where in the year just past the bills of only four patrons exceeded that amount and where the increase would double the bills of three-fourths of the consumers.

Duty to Render Service.—Public Utilities may not refuse reasonable extensions for service, the Missouri Public Service Commission has declared, merely because the immediate compensation therefrom is inadequate, but are obligated to make extensions which will be at once self-supporting or which give assurance of ultimately becoming so, and others upon equitable terms.

Justification of Coal Riders.—In approving the inclusion of a variable fuel clause in the rates of the Missouri Public Utilities Company for seventeen places served by it the Public Service Commission of the state observed that the condition in which a utility incurring approximately one-half of its production expenditures for coal is thrown when a severe increase in the cost of fuel occurs justifies the application of variable rates equitably based upon the costs of fuel obtaining prior to the emergency.

Present Rates Continued at East St. Louis.—An order continuing in effect the present rates of the East St. Louis Light & Power Company, East St. Louis, Ill., and granting a 10 per cent advance in one rate of the Alton Gas & Electric Company, Alton, Ill., has been handed down by the Illinois Public Utilities Commission. The increase granted to the Alton company affects only users of small motors. Present rates were fixed a year ago. The order continues them indefinitely but imposes the burden of proof as to future fairness on the companies.

Service Charge Permitted Small Company Operating Several Businesses in Combination.—The Mountain Grove Creamery, Ice & Electric Company, a small company operating in combination several branches of business, has been permitted by the Missouri Public Service Commission, in the absence of proper evidence concerning the allocation of costs, to exact as a part of the minimum charge a monthly service charge of 50 cents, increasing its net income approximately $1,500 on property valued at $16,000 and operated at a claimed loss of $2,181 in eleven months.

Apportionment of Gas and Electric Charges Where Company Operates Two Departments.—In granting increased electric rates to the Napa Valley Electric Company, which also operates a gas department, the California Railroad Commission dwelt on the necessity of properly apportioning expenses common to the two divisions. The company's electric revenues now constitute more than 91 per cent of the total business, and its gas consumers number 105 out of a total of 769. These facts were carefully considered by the commission. The value of a leased electric line was not allowed to figure in the estimates of return, this line having been included in a prior application of the lessor, the Snow Mountain Water & Power Company, as a part of that company's property entitled to return.

Recent Court Decisions

Findings of higher courts in legal cases involving electric light, power and other public utility companies

Breaking of Dam Must Be Shown to Have Been Result of Negligence to Justify Award of Damages.—The Supreme Court of New Hampshire has laid down the principle, in White vs. Woodward, that where there is doubt as to the cause for the breaking of a dam it is not enough to establish that there was negligence in its construction and maintenance; before damages can be awarded to parties injured by the overflow, it must be shown that such negligence caused the dam to fail. (111 At. 494.)*

United States District Court Upsets Commission's Method of Valuation.—The United States District Court for the Western District of Missouri has decided in favor of the St. Joseph Railway, Light, Heat & Power Company in a suit brought against the Missouri Public Service Commission because the commission had fixed street railway fares and steam-heating rates on a valuation based on original cost, when obtained, and when not obtainable on average prices for a fixed period of five years before war prices prevailed. Holding this method of valuation to violate the Fourteenth Amendment of the United States Constitution, the court granted a permanent injunction against the commission, which has appealed the case to the United States Supreme Court.

Jurisdiction to Restrain Enforcement of Statutory Rate Must Await Action of State Commission.—Where a light and power company supplying electricity at rates fixed by statute but subject to change by a state commission has applied to the commission for an increase in rates, it cannot, according to a decision of the United States District Court for the Western Division of Wisconsin, in Wisconsin-Minnesota Light & Power Company vs. Railroad Commission of Wisconsin, pending action on such application, invoke the jurisdiction of a court of equity to enjoin enforcement of the existing rates as confiscatory; nor does the fact that the commission has acted in respect to certain of the rates unsatisfactorily to the company give the court jurisdiction to review all the rates, which are more or less interdependent and must be considered together to determine their reasonableness, in advance of final action by the commission. The court therefore refused to issue a preliminary injunction against rates in force. (267 Fed. 711.)

*The left-hand numbers refer to the volume and the right-hand numbers to the page of the National Reporter System.

Men of the Industry

Changes in Personnel, Responsibilities and Association Appointments of Men Engaged in Professional, Executive, Operating and Commercial Branches of the Industry

W. J. Tharp, the secretary of the Little Rock (Ark.) Railway & Electric Company, has been appointed secretary of the Arkansas Utilities Association, succeeding S. E. Dillon, manager of the public utilities of Hot Springs, who has recently resigned.

Frederick D. Gordon, who joined the organization of the Cumberland County Power & Light Company, Portland, Me., on Oct. 1 of this year, has been appointed general manager of the company, succeeding A. H. Ford, who resigned more than a year ago. Since that time the company has been without a general manager. Mr. Gordon was formerly general manager of the Androscoggin Electric Company, Lewiston, Me., with which he was connected for a number of years.

F. D. GORDON

Herbert T. Lewis on Dec. 1, 1920, took up the duties of district manager of the Robbins & Myers Company at Philadelphia, succeeding A. S. Tarr. Mr. Lewis joined the sales force in Philadelphia Sept. 22, 1918, and has rapidly worked up to his present position. Among his associates he is familiarly known as "Butts."

Richard G. Harris, who has recently been appointed Pacific Coast manager of the Standard Underground Cable Company, succeeds John P. Bell. Mr. Bell will hereafter devote his time to the growing demands of his export and import business. Mr. Harris has been connected with the company since 1909. He was at first a member of the staff of the general offices at Pittsburgh and employed on special development matters at its Perth Amboy (N. J.) factories. Later he was sales engineer with the New York office of the company. For the last eight years he has been manager of the Montreal office of the Standard Underground Cable Company of Canada, Ltd.

W. G. Stearns, for many years associated with the Standard Underground Cable Company on the Pacific Coast, has been appointed special sales agent, with offices at San Francisco.

Otto E. Osthoff, vice-president of H. M. Byllesby & Company, Chicago, who has recently returned from a tour of inspection of that company's properties in California, reports that, despite industrial recessions and readjustments, utilities in that section will not be affected because they are dealing in absolute necessities. This feeling, he states, is largely influenced by the fair and constructive attitude of the California Railroad Commission.

Robert D. Maxwell, S. E. Sutherland, Charles Smith, and W. G. Sheehan have recently been appointed district managers of the Crystal Washing Machine Division, Mallory Industries, which has headquarters at Chicago. Mr. Maxwell was formerly connected with the Studebaker sales organization of southern California both as branch manager and as distributer. He will have charge of the Middle West district. Mr. Smith will be district manager for the South. Until recently he occupied the same position with the Federal Motor Car Company. His headquarters will be at New Orleans. Mr. Sutherland, formerly with the Procter & Gamble Distributing Company, becomes district manager of the South Central States with headquarters at Cincinnati. Mr. Sheehan, who was recently discharged with the rank of major from the office of the chief of overseas material production under Brig.-Gen. R. E. Wood, will be stationed at Port Chester, N. Y., where the executive offices of the Crystal organization as well as one of its three factories are situated. Previous to his army career Mr. Sheehan was production manager of the Locke Insulator Company of Victor and Lima, N. Y.

Earl C. Lewis has been appointed assistant mechanical engineer with the Hygrade Lamp Company, Salem, Mass. Mr. Lewis is a graduate of the Massachusetts Institute of Technology and was formerly employed by the General Electric Company at its Lynn and Schenectady factories. For a year he was an inspector for the Factory Mutual Fire Insurance Company of Boston, and during the war he served in the United States Naval Experiment Station at New London, Conn., working on submarine detection and electric torpedoes.

R. L. Eltringham, formerly electrical engineer of the California Industrial Accident Commission, has resigned to become manager-secretary of the California Electrical Co-operative Campaign. His new duties began on Jan. 1, 1921. Mr. Eltringham, who is forty years old, has had an extended experience in electrical affairs. He operated one of the earliest electric lighting plants in Pennsylvania, his native state, when a youth and held various positions with pioneer lighting and street-railway companies in the East. Before the age of twenty he was assistant to the general manager of the Lakeside (Pa.) Railway Company. After a short experience with the Cramp Shipbuilding Company he was employed by the Baldwin Locomotive Company in its electrical department when the manufacture of electric mine locomotives was first undertaken in conjunction with the Westinghouse Electric & Manufacturing Company. He went West in 1901 and was employed by the Consumers' Gas Association of San Francisco and later by the Pacific Mail Steamship Company on electrical work. From 1906 to 1907 he was employed by the Commonwealth Edison Company of Chicago. He returned to California in 1908 to take charge of the electrical power work of the Empire Construction Company. Resigning that position in 1910, he became industrial power engineer of the Great Western Power Company of San Francisco, where he remained until in 1914 he accepted the position of electrical engineer of the accident commission. Mr. Eltringham has been active in the formulation and administration of the various electrical safety regulations of that commission, including the California utilization safety orders, the mine safety orders and the lighting safety orders. He is a member of the American Institute of Electrical Engineers and the Illuminating Engineering Society.

R. L. ELTRINGHAM

Trade and Market Conditions

Business Reviews, Together with Market Letters from Important Trade Centers, on the Supply, Demand and Prevailing Prices of Electrical Apparatus and Supplies

Buyers' Market Predominates After Heavy Year

IN LIKE a lamb but out like a lion was all very well as a characterization of the electrical industry for the year 1919, but for the year just passed the conditions were exactly reversed. The electrical industry has slept off very quietly the last two or three months of the year 1920 and is entering the new year with prospects of much work to be done, especially in relation to a nation-wide building program.

Looking back, the year has proved prosperous for manufacturer and jobber, although, especially for the manufacturer, it has been a hectic year. Conditions of production have been unsatisfactory, to say the least. Labor shortage, independence and inefficiency; lack of raw materials, semi-finished products and coal; railway tie-ups and freight congestion caused by strikes, cold weather, snow and car shortage—these have been the main factors manufacturers have had to contend with in the face of a demand which it was beyond their power to satisfy. Of course, prices continued to rise beyond the levels of the previous year, for the electrical industry and for every other industry, and price at time of shipment was quite general.

But by the middle of the year money was beginning to get pretty tight and its cost mounted, banks were curtailing loans, manufacturers, fortunately, were having difficulty borrowing money with which to add to their already augmented capacity, when the public took it upon itself to stop buying what it did not need at prices which it thought were beyond all reason—and the house of cards tumbled to the ground. Silk, cotton, woolen and leather industries, followed shortly by the automobile industry, went begging for orders, retail clothing and apparel stores sliced big edges off their prices, building started to decline in certain sections, manufacturers, jobbers and retailers in lines outside of the electrical had to liquidate some of their growing stocks and business in general was on the decline. Credits and collections took on increased importance and were followed and pushed with avidity.

And, in turn, during the last quarter of the year the electrical industry began to feel the pinch. During the last two months business has dropped to a very quiet level, prices have started downward, stocks have built up in jobbers' hands even under cancellations of orders, and manufacturers, many with several months' orders on their books and those whose orders amount to very little, have begun to limit their production so that it is commensurate with the demand existing at this time. Liquidation of inventories is general.

Demand is off, building is conspicuous by its inactivity, labor is plentiful in almost every section, much capacity is idle, materials and apparatus unknown to stock all year can now be had immediately, and more cars are surplus than at any previous time in the last eighteen months. In other words, the sellers' market turned to the present buyers' market.

But through it all there are bright prospects for 1921, once the year has got fully under way. Hardly a city of importance but is vitally in need of apartments, hotels, commercial buildings and residences, and the country in general needs residences. Recent investigations into building-material prices and combinations in New York have resulted in exposures the outcome of which has been lowered prices and fines. So it would seem one of the obstacles to building in the past year—high prices of materials—has been overcome to an extent, and the building outlook when the warm weather next makes its appearance looks good. From several quarters, however, is heard the opinion that it will be midsummer before much building activity makes itself felt.

Exports Held at Unexpected Rates

THE matter of electrical exports has provided one of the surprises of the year. At the present time these are running at a yearly average of about $94,000,000, a gain of $4,000,000 over those of the year 1919. In spite of the high rates of exchange existing in most of the foreign markets, working against the purchase of material in the United States, this outlet has continued at a rate which is quite remarkable. It is true the higher prices probably had something to do with the good showing in dollars and cents, but the answer is that the market held up well.

Metals Broke Badly in Last Half Year

COPPER during the year reached the lowest point recorded since 1914. Opening high at 19 cents, it fluctuated in the eighteens till the last of March and during most of April was quoted at 19.25 cents. This was the highest point reached, and it was held by the producers for a month. A quarter-cent reduction brought it to 19 cents again, and this level continued until the last of August, three and one-half months. From then on the decline was gradual, except during October, when it declined 3½ cents, until the latter part of December. During this last month producers were quoting 14 cents for prompt shipment, but the outside market was shading at times as much as ½ cent.

Copper	—Dec. 30, 1919— £ s d	—Dec. 27, 1920— £ s d
London, standard spot	116 15 0	72 5 0
	Cents per Pound	Cents per Pound
Prime Lake	19.00–19.50	13.75
Electrolytic	18.75–19.00	14.00
Casting	18.50	13.00
Wire base	21.50–22.00	16.00–16.50
Lead, trust price	7.50	4.75
Antimony	9.62½	5.25
Nickel, ingot	41.00–42.00	43.00
Sheet zinc, f.o.b. smelter	11.50	11.50
Zinc, spot	9.00–9.10	6.00–6.10
Tin	59.50	33.00
Aluminum, 98 to 99 per cent	32.00–33.00	28.50

OLD METALS

	Cents per Pound	Cents per Pound
Heavy copper and wire	17.00–17.50	11.00–11.50
Brass, heavy	9.75–10.25	6.00–6.50
Brass, light	7.75–8.00	4.50–5.00
Lead, heavy	6.00–6.25	3.50–4.00
Zinc, old scrap	4.75–5.00	3.25–3.50

Copper-wire base, net, at the mill reached its highest point, 23 cents, in March and, after holding for seven weeks, dropped to 22.50 cents for nearly five months, gradually easing off to the closing price of 16 to 16.50 cents. Insulated wires followed this course from October on.

Lead ran a strong race, reaching 9.25 cents a pound in New York in March and April, official price, but after fluctuating a bit in the eights it settled for an easy decline which started in August and finished at a present price of 4.75 cents. Much of the time when the prices were high the outside market was holding for a half cent or so higher. On the decline, however, that market trailed around one-quarter cent.

Early in December independent steel mills began cutting their prices to approach and finally to meet those quoted by the United States Steel Corporation. Pipe prices are said to be the only ones that now show a disparity.

Apparatus Shipments Ran Long

MANUFACTURERS carried over into the year very heavy bookings of motors, generators, turbines, transformers and other classes of apparatus. Stocks of motors in sizes from 1 hp. to 50 hp. virtually have not existed in manufacturers' or local warehouses all year, although in December production had begun to catch up to the point that some common sizes could be picked up for immediate delivery. Stocks of these popular sizes, from 1 hp. to 10 hp., became more plentiful in the hands of dealers and second hands. Shipments from factory during the year ranged up to six months, with many quotations around three and four months. Prices advanced around 15 per cent and for a time orders were received with price open.

Distribution transformers enjoyed a good year with production going to capacity. Here and there, however, material shortages proved very annoying to shipments, the most common of which were in long-fiber cotton, magnet wire, sheet steel and iron castings. Factory and local stocks generally were depleted, and shipments ranged at times up to eighteen weeks. Apparatus transformers ran up to ten months under good demand. Improvement was noticed in the standardization of ratings for special transformers.

Demand for generators and turbines increased after the first of the year with good capacity running in the shops and shipments running from six to twelve months, depending on size, some quotations requiring eighteen months. Difficulty was experienced early in the year because of a shortage of capable labor, but this was overcome later on.

Wire Supply Held Well

WIRE mills were able to keep the trade supplied with rubber-covered wire almost without fail throughout the year. Here and there shortages occurred because of rail tie-ups, of course; but the trade did not suffer from the lack. Bookings of the first few months gave evidence of double the 1919 rate, but the year came through with an increase of only about 12 per cent on rubber-covered. Quotations to the trade were as high as $14 per 1,000 in 5,000-ft. lots in New York, while in December just passed they had fallen to around $8.50.

Weatherproof-wire stocks in the sizes 6, 8, 10 and 12 were generally reported poor throughout the country, but those too have been replenished. Magnet wire in the smaller sizes was virtually off the market for many weeks, so great was the demand for it in the manufacture of small motors, transformers, control equipment, etc. Lamp cords and heater cord were gone from stock for the most part of the year too and were not back on the market in good supply till late fall.

Pipe Just Returning to Stocks

PROBABLY the shortest material in the wiring line was rigid conduit. Raw-material shortage was accounted for in the extraordinary demand for its basic material, merchant pipe, for the oil industry. Jobbers had no stocks of ½-in. and ¾-in. pipe all year, and it is just in the last two months that anything like stocks have accumulated. Prices have been high, quotations in New York to the trade of ½-in. black having been as high as $110 per 1,000 in 1,000-ft. lots, when available. Prices nearer $70 are in effect now. Outlet boxes have followed the pipe market quite closely as concerns supply and demand.

Big Increase in Lamp Sales

A PARTICULARLY strong year has been experienced in the sale of lamps. While sales of large types in 1919 amounted to 183,000,000, those for 1920 have been estimated at 230,000,000. Manufacturers have been concentrating their efforts on turnover of B agents' stocks, and they kept in force during the year the 5 per cent additional compensation rider on list value of lamp sales from these B agents' stocks, regardless of rate of turnover, instead of putting into effect a rider giving additional compensation based on five and six turnovers. This same rider is to be continued on into 1920 pending the collection of more data on turnover.

During the year lamp stocks were seldom filled up solid on B agents' shelves, so great was the demand. Transportation and raw material shortage were the chief factors in this condition of spotty stocks. On April 1 price increases varying from 10 to 15 per cent were applied on the common run of large lamps, while at the same time certain large sizes were reduced. To reduce stocks of in-between voltages manufacturers are making an effort to reduce the types produced to voltages of 110, 115 and 120 volts.

In the courts the United States Circuit Court of Appeals sustained the Langmuir gas-filled lamp patent (General Electric vs. Nitro-Tungsten) and the United States District Court upheld the Coolidge wrought-tungsten patent (General Electric vs. Independent Lamp & Wire), following which an appeal was filed.

Socket-Device Buying Heavy

FROM what was virtually an insatiable demand for heating appliances and motor-driven appliances during the first five months the market turned to one later in the year in which the price played such a large part that the public lost interest and stopped purchasing. Stocks turned from nothing to sufficient for the demand of motor-driven goods, while those of heating devices have not yet been filled, especially in hollow ware.

Consequently the unheard-of demand for fractional-horsepower motors receded to the point where some manufacturers are offering immediate shipments. Early in the year shipments were quoted over a year with price open.

Wiring-Material Stocks Spotty

IN CONSEQUENCE of the heavy building demand existing all over the country during the first six months of the year there was a call for wiring materials which kept jobbers' stocks virtually depleted. Transportation failures, of course, kept raw materials from the producers and kept finished product from the jobbers. Such items as rigid conduit, non-metallic flexible conduit, flexible armored conductor, knobs, tubes, cleats and schedule material were sold before being received by the jobber and frequently never entered the warehouse. They just bounced from incoming to outgoing trucks. Pyramiding of orders resulted, with shipments quoted months in advance at prices that should rule at time of shipment. Rubber-covered-wire stocks did not reach such low levels.

It was in July that manufacturers began to catch up, and shortly after building activity fell off a little. Thereafter demand gradually fell and shipments came in better, so that by late fall jobbers' stocks had built up again on most items. But the call was light and stocks became top-heavy by November, and with the inventory period in sight jobbers lowered their prices to liquidate.

Armored-Conductor Market Weak

SHORTAGE of steel strip, because of delivery and raw-material conditions, was a prime factor in the poor stocks of flexible armored conductor existing all year up to September. Demand indeed was heavy but by late summer it fell off. The present market is down to about $65 per 1,000 for 5,000 ft. of 2-wire No. 14 in New York whereas it had been up to around $110. Production increased about 25 per cent over 1919.

Pole-Line Equipment Sold Well

CENTRAL stations ordered a good volume of poles, pins, cross-arms, hardware and high-tension insulators during the year. Of course, a lot were for maintenance, but new extensions ate up a large quantity. Insulators all the year were on very long shipments, up to eight months, depending on type and voltage. Production was hindered because of the heavy turnover of labor in the kilns. Foreign buying of insulators and steel towers was very heavy.

Transportation was a deterrent factor in supplies of woodpole materials in jobbers' yards. At the mills these generally were good, however, and in the fall months shipments came back to about normal conditions and stocks filled up. Better labor conditions in the woods are foreseen.

Hardware stocks suffered for most of the year and are only now getting back into shape. Demand could not be supplied easily because of steel shortage and car tie-up.

THE WEEK
IN TRADE

Prices When Quoted Are Those Prevailing at the Opening of Business on Monday of This Week for Points West of the Mississippi River and on Tuesday for All Eastern Points

CHRISTMAS buying did fall off as compared with that of last year, as predicted in most sections of the country. Although it finished up strong, the light pre-season business kept the total down. Activity in the general run of electrical supplies is not great, especially as the inventory season is at hand. At the same time, many industrials are taking what they find to be a slack period to make repairs and replacements. This has been slower of accomplishment in the lumber camps of the Northwest, however, than was expected.

Stocks of virtually all supplies are in good condition, and naturally buying is of such a nature as to supply present needs only. Motors are rather easy to get in the smaller integral sizes. Large back orders of pipe are still on manufacturers' books. In New York the price of flexible armored conductor has eased off a lot.

Collections show no improvement, and no let-up in the energy required to keep them even on their present level can be permitted.

NEW YORK

DEMAND seems even lighter than has been the case all along, following the impetus which Christmas sales gave to certain lines such as appliances. The holiday trade as a matter of fact, though considerable, does not appear to have been up to expectations. Jobbers are busily engaged in taking inventories, and that is another reason for the quietness previously noted. As yet it is still too early to make a comparison between the size of stocks jobbers are carrying now and last year at this time, but as a general thing this year's inventory will run into much larger figures.

Prices on flexible-armored cable have broken to lower levels, but except for the wiring lines quotations are steady. Collections remain slow and are being hard pushed. Contractor-dealers are not very busy, but a fair amount of wiring and repair work is being carried on by industrials. Many of the latter are now no longer pushed to capacity and hence for the first time have opportunity to overhaul equipment thoroughly.

Rubber-Covered Wire.—Demand remains poor and stocks too large. In 10,000-ft. quantities No. 14 is quoted at from $8.50 to $9.35 per 1,000 ft. net.

Lamps.—Though a slight recession in demand is noted in some quarters recently sales on the whole are excellent. Stocks in most cases are well filled on all sizes, occasional complaint being heard of the supply of round-bulb and 100-watt lamps, however.

Flexible Armored Conductor.—Prices have eased off considerably, and some jobbers report fairly good sales at a level of $65 per 1,000 ft. for No. 14 two-wire, though others are still asking $80-85 net in 1,000-ft. quantities. Deliveries of any reasonable quantity are from stock.

Conduit.—Demand has fallen off considerably, with fairly good stocks of most sizes the rule. Prices cover a wide range, from $70 to $85 net per 1,000 ft. being quoted by jobbers on ½-in. black in 2,500-lb. lots.

Conduit Fittings.—Sales are in about the same proportion as for conduit, with a fair but not extra-heavy movement. Stocks are ample.

Tape.—Demand is light, and as a consequence good stocks of both friction and rubber have accumulated. Depending upon the grade and the manufacturer, friction tape ranges from 50 cents to 55 cents per pound and rubber from 41 cents to 50 cents in 100-lb. lots, net.

Heating Appliances.—Christmas demand caused stocks to move rapidly, but the holiday trade from most accounts does not seem to have reached the level of other years. Hollow-ware items are still spotty, some jobbers carrying over considerable stocks which arrived at the last minute, while others are cleaned out.

Schedule Material.—Porcelain has ceased to hold up the supply of some items as stocks are fully ample to meet the existing light demand.

Storage Batteries.—Manufacturers of starting and lighting batteries have made reductions in price of from 20 to 28 per cent, depending on type, effective Jan. 1 in general. One producer's cut has a low limit of 10 per cent. Lists have been reduced and with them the discounts.

Wireless.—Christmas demand for wireless equipment has been heavy. Individual pieces and small parts sell especially well for making up into sets, and unit equipments have found a good market. Prices show little change and stocks are good.

CHICAGO

The Christmas shopping season closed with a rush of buying on the part of the public, although the gross money volume was below last year's total. Estimates of the reduction run all the way from 10 to 35 per cent. In general electrical goods were favored in the buying. There was some price cutting by retailers of tree outfits, and some of them were observed to be offering lighting outfits below cost; but dealers finally were sold out. Supplies of heating appliances in dealers' hands were well cleaned out.

Construction is waiting for price reductions in building materials and possibly in the labor market, and until some stability in cost is established there promises to be no activity. Contractor-dealers have but little to do and jobbers' stocks are now well built up. The depletion of jobbers' stocks a few weeks ago was so pronounced that most producers have been enabled to operate at capacity up to the present, but in the last week or two some tendency toward curtailment has been noted.

Rigid Conduit.—Previously reported shortage of ¾-in. and ½-in. sizes has now been overcome, all sizes being obtainable in reasonable quantities from stock.

Non-Metallic Flexible Conduit.—Plenty of stock of all sizes is reported, and an expectation of reduced prices is noted. Factories are still producing in large quantities and jobber stocks are well filled.

Flexible Armored Conductor.—Demand is light, being confined for the most part to replacement requirements. Stocks are in position to handle all requirements. No talk of price changes is heard, current quotation on No. 14 two-wire being $85 for 1,000 ft.

Wire.—Ample stocks are on hand and consumption is below normal.

Schedule Material.—Ample shipments have been coming through from factories for some time, and, demand being light, jobbers' stocks are built up to a point about as high as desirable. Prices are thus far firm.

Transformers.—After the slump recorded a month ago, when farmers unanimously quit buying, there has been a gradual resumption of demand. The aggregate of orders placed has not been large, but a comfortable business is being done. Credit conditions in the Middle West are improving, which improvement should be at once reflected in the demand for transformers for farmers' lines.

Electric Heaters.—Business has been exceptionally good all through the fall, and factories are reported as being still busy. Jobbers' stocks are not so heavy as they should be and orders are continually being placed.

Electric Ranges.—Although actual sales are light inquiries are of such volume as to promise good business in the spring.

BOSTON

In the jobbers' field trade was well sustained until the close of the year. Accumulated back orders and continuous demands for replacing used-up material kept many houses busy, notwithstanding local dullness in the textile and other industrial lines where mills have been running on part time for weeks or else have been temporarily closed. The retail trade in electrical appliances bade fair at the end of last week to round out with an excellent showing. While the record sales of 1919 for the holiday trade were not reached in many cases there is good reason to believe that when the year's totals and the December figures are compiled 1920 will display a thoroughly satisfactory volume of business in comparison with earlier so-called normal years.

Stocks have been built up by the receipt of long-delayed shipments, and in most lines jobbers are well prepared to handle the new year's business. A general feeling prevails in the electrical industry that the readjustment period will be less trying and less prolonged than many other lines where prices were carried far higher. Prices last week showed little change, barring softening tendencies in annunciator, weatherproof and rubber-covered wire. Collections were quoted as unsatisfactory by leading jobbing houses last week, due to unemployment in industrial centers.

Wire.—Rubber-covered No. 14 wire was quoted at the week end around $9 per 1,000 ft. in 5,000-ft. lots, with plentiful supplies. Weatherproof base was 20 cents to 21 cents, and early this week lower quotations on annunciator wire were to be ready at the prominent jobbing houses. Demand is moderate.

Motors.—Distributers report improving stocks, and one prominent house had on hand for immediate delivery on Christmas Eve single-phase and three-phase motors of practically all standard sizes up to about 35-hp. rating. Prices were firm at the end of the week, although rumors of a moderate reduction to be forthcoming early this year are circulating about the trade.

Lamps.—Central-station buying has been excellent, and one leading lamp house reports that the 1920 business will show from 25 to 40 per cent increase over the year before among the electric utility companies on its books. Current requirements are being admirably met.

Flexible Armored Conductor.—The demand is moderate, with good stocks. Prices ran around $85 per 1,000 ft. on No. 14 single-strip at the close of last week.

"Nail-it" Knobs.—These sell around $32 per 1,000 in barrel lots and are not hard to obtain. Their movement is rather sluggish.

Radiant Heaters.—Protracted mild weather has helped sales remarkably.

Non-Metallic Flexible Conduit.—Prices held at recent levels as the week closed, with ample stocks and moderate demand.

Appliances.—Portable lamps, toasters, percolators and vacuum cleaners have moved actively in the past fortnight. Sharp reductions in prices have featured not a few retail sales, especially on portable lamps. Electrical toys were unusually prominent this year in the retail trade.

ATLANTA

Wholesale trade has reached its low ebb for the year, all jobbers reporting a heavy slump in the receipt of orders, due in a great measure, no doubt, to the approaching inventory period. The retail trade is making every effort to reduce its inventories and is holding off on orders until after the first of the year. No general feeling of pessimism, however, is voiced by the jobbing fraternity. On the other hand, their attitude is one of optimistic expectation, and they express confidence that the easing in the labor situation, willingness on the part of unskilled labor to accept a lower wage schedule and the reduction in the price of building material cannot but presage the return of building activities. Retailers who have allowed their stocks to reach a very low point will naturally place orders for replenishment during the first of the new year, and things should resume a more or less normal basis early in the spring.

The Federal Reserve Bank of this district states that it discounted $203,000,000 of agricultural paper as against $93,000,000 last year, which throws a light on the general credit situation throughout the territory. A considerable amount of this paper will be renewed, thus causing tight money for several months yet.

Wire.—Stocks of wire are reported in first-class shape with the demand only fair, rubber-covered being on an 18-cent and weatherproof on a 20-cent base.

Flexible Metallic Conduit.—Jobbers have allowed stocks to run quite low and will not reorder conduit until after Jan. 1. Such supplies as are on hand are moving slowly and factory shipments are reported good. Prices: Lots of 1,000 ft. to 2,500 ft., ½-in., $10.60; ¾-in., $13.78; 1-in., $24.38 per 100 ft.

Rigid Conduit.—Stocks in general have become somewhat spotty, shortage being reported in popular sizes of both black and galvanized. The demand continues to hold up fairly well, with a price reduction of approximately 12 per cent. Prices: Galvanized, ½-in., $8.30; 1-in., $16.60; 2-in., $35.50; black, ½-in., $8; 1-in., $15.70; 2-in., $34 per 100 ft.

Distribution Transformers.—Several jobbers continue to report difficulty in obtaining satisfactory shipments in the popular sizes, though one house reports a fair quantity on hand. In general, however, the transformer situation is not wholly satisfactory.

Schedule Material.—Stocks are in better shape than for some time past, even porcelain being on hand in sufficient quantities for all current demands. All material, however, is moving slowly and no price changes are yet reported.

Stamped Steel Boxes.—Stocks show considerable improvement for the past few weeks and, as is true of all building material, are moving but little.

ST. LOUIS

Little has occurred in electrical circles here in the last week, but it is thought that the end of the holiday season rush and the completion of inventories will be followed by numerous changes. The demand for staple goods continues to be very dull, but the sales of seasonable goods and holiday specialties will bring the volume of business for December to satisfactory proportions, though jobbers do not expect to equal the December, 1919, volume. They stocked lightly and in most cases were able to clear off their shelves. A few reported shortages in some lines of appliances. Dealers were not heavily stocked with holiday specialties but were able to meet a fairly good demand.

Very little improvement can be noted in the construction situation. There is practically no housebuilding, and industrial jobs are generally small and unimportant. Plans for spring are usually conditioned on the status of prices and wages at that time. Collections have shown no change, and an average of about sixty days continues to be the rule.

Wire.—The decline in price reported last week has had the effect of increasing sales slightly. Supply is still in advance of demand, however. Contractor-dealers report an increase in the number of house-wiring jobs, most of them to be installed after the first of the year, and this also has speeded up sales.

Rigid Conduit.—Jobbers' stocks are unusually complete, supplies of the ¾-in. and ½-in. black having improved during the last week. The smaller sizes of the galvanized conduit are a trifle spotty, but demand has slowed up so that it will not be long before jobbers build up their stocks of these. Prices remain the same, ½-in. black being quoted around $80 per 1,000 ft. in lots of 5,000 ft.

Meters.—Stocks are not complete and jobbers have back orders on their books. Their regular customers are being taken care of, but deliveries to new customers range from one month to three and four months. Demand shows no indications of slowing down.

Motors.—Practically all sizes are easier than was the case six weeks ago. The sizes between 2 hp. and 15 hp. still remain scarcer than other sizes, but deliveries on these have shortened to around three months. Demand is quiet. There are large quantities of fractional motors to be had.

Raditors.—In spite of the cold weather that has prevailed during the past week demand has not quickened. Sales are good, however. Jobbers have uniformly large stocks but do not anticipate any trouble in turning them over before spring.

Knobs, Tubes, Cleats.—These are in good supply and can be shipped immediately in ordinary-size lots. Demand has fallen off considerably. Prices are firm. Representative quotations are $9.90 per 1,000 of the 3-in. x $\frac{7}{16}$-in. tubes.

Hollow Ware.—Christmas sales were good and jobbers were well able to meet demand with the exception of that for fancy percolators and curling irons.

Linemen's Tools.—Jobbers have not had any on hand for some time, but are promising delivery in about four months. There are many orders on the books, but inquiries and new orders have slackened.

SAN FRANCISCO

Building permits have increased in value, for the housing situation requires immediate relief whatever the cost. On the other hand, counter business has shown a considerable decrease because of late buying. Collections are fair to good, although light Christmas buying and heavy stock carried over by most dealers into 1921 will probably affect electrical credits and may result for several months at least in hand-to-mouth buying.

Railroad shipments are coming through in good time from the East. Generally speaking, California crops were of the bumper variety during 1920.

Line Material.—The largest electrical sales just now are for line material, and even heavier buying is anticipated. The Pacific Gas & Electric Company is the biggest customer of the moment. Railroad freight solicitors report many cars of insulators, poles and pole-line hardware in transit.

Lamps.—Jobbers cleaned out practically all their Christmas tree outfits, and most dealers report heavy sales.

Heating Appliances.—Radiator sales during Christmas week fell off. Sales of hollow ware, especially of urn-type percolators, were disappointingly low and will result in big stocks being carried over into 1921. It is frankly stated that present list prices are considered too high by the public, although virtually every upright toaster was sold and sales of high-priced flatirons were reported good by dealers who made special sales efforts.

Household Appliances.—Washing-machine prices seem to be decreasing make by make, the average price on the cylinder model now being about $160. Sales of washers during the holidays fell off considerably despite special-inducement campaigns. Ironing-machine business also has decreased, but it is expected that better delivery and a better knowledge of the line will culminate in 1921 sales that will run higher as compared with washer sales.

Ranges.—Range sales are slower. No special effort is being made now to sell ranges by the power companies, although expert solicitors will probably be active about March, when much new power will be available. Factory deliveries are much better, and the completion of orders on file has resulted in fair stocks on the Coast.

SEATTLE—PORTLAND

With but very few exceptions both jobbers and dealers in Seattle and the Puget Sound district report holiday electrical sales the lightest in years despite united efforts to accelerate them. The movement in hollowware, particularly percolators, toasters, flatirons, etc., was comparatively satisfactory, but not nearly so heavy as could have reasonably been expected. Vacuum cleaners and sewing machines just prior to the holidays showed a spurt, but even these sales fell far below original expectations. The movement of washing machines, generally speaking, was very disappointing; in fact, the volume of sales usually attributed to the Christmas season did not materialize. At present the electrical business, from both the jobbers' and the dealers' standpoint, is exceptionally dull. Stocks, as a whole, are in first-class shape, and in spite of rumors of price reduction affecting all electrical merchandise there have been no changes worth mentioning, with exception of rubber-covered wire, for several weeks.

Motors.—Inquiries from lumber mills and small industrial plants prior to the holidays have not resulted in the orders anticipated. Apparently prospective buyers are awaiting price declines, which jobbers predict will be very slow in coming. Shortage of fractional sizes is gradually being overcome, and at present stocks of all sizes are in fair shape. Demand for smaller sizes is fair, but the larger types are not moving.

Lamps.—The market is in fairly good condition, and both jobbers and dealers express satisfaction over the season's business to date. Movement of industrial types is at a minimum, most of the activity being in residential types.

Conduit.—Demand, owing to negligible amount of new construction, is very light and jobbers have accumulated a considerable stock of popular sizes.

Vacuum Cleaners.—A comparatively heavy movement was experienced just prior to Christmas, and both jobbers and dealers expressed considerable satisfaction, considering ruling conditions.

Wire.—Rubber-covered wire is still tending downward. Owing to very light demand along all lines stocks are accumulating. It is believed actual demand will not materialize until late spring and that the peak of demand will not be reached before next fall.

Schedule Material.—There is scarcely any call, and accordingly complete stocks are accumulating. There has been no definite change in prices recently.

SALT LAKE CITY—DENVER

Jobbers report stocks considerably heavier this year than in the corresponding period of 1919. Dealers, however, are not so abundantly stocked. Both conditions are partly explained in that dealers have been placing orders charily, showing a tendency in the past few months to order from their jobbers in extremely small consignments. As the year comes to a close electrical firms find themselves well stocked in practically all lines with factories well caught up in their orders. There is no intimation of a general recession in prices except in products manufactured from steel and copper. Conduit is selling at a considerably lower figure than it was a few months ago, and so is copper wire. No reduction is given on prices of appliances, and factories report that none can be expected in the immediate future. Manufacturers of washing machines and vacuum cleaners are guaranteeing stable prices to April 1 and some even to July 1.

Jobbers believe that a general price recession would not only be practicable from the manufacturer's point of view but also beneficial to the trade. The opinion is held in some quarters that present prices of washers and cleaners are unduly inflated, including certain fictitious values. Credit conditions continue unimproved and there are no positive indications that they will grow better after the new year is launched. Improvement along these lines in the Intermountain West waits upon federal legislation looking to the protection of the sheep, cattle and agricultural industries.

Motors.—Factories have almost caught up on orders. The demand is good, especially for pumping motors.

Lamps.—All dealers report stocks ample and demand brisk. Deliveries are good.

Conduit.—There is a tendency in some quarters to accumulative overstocks. The demand is light, since the building season is practically over.

Wire.—Prices are down to the bottom and deliveries are reported good.

Schedule Material.—Prices remain exceedingly high. This is the off season and the demand is very light.

Manufacturers' Activities

Devoted to the Business Side of Manufacturing, Distribution and Sales, News from Jobbers and Foreign Fields and a Record of New Devices and Trade Literature

Fire Does Not Halt Line Material Company

A report from L. E. Hendee, vice-president of the Line Material Company, South Milwaukee, Wis., states that the recent fire which wiped out the office did not halt the company's operations. All vital records were found intact in the safes, while the operating plant was undamaged. Mr. Hendee states that the company is galvanizing and shipping material.

Ward Production Department Not Sold

A statement has been received from P. H. Ward, president of the Ward Electric Company, Philadelphia, to the effect that there is no truth in the rumor that it has sold the manufacturing branch of its business to the Machen Electrical Manufacturing Company. Mr. Ward states that the error arose through negotiations between the Machen company and the Ward-Stoddard company, which formerly manufactured push-button switches for the Ward Electric Company.

Wesche Electric Plans to Increase Production

Announcement has been received from the B. A. Wesche Electric Company, Cincinnati, Ohio, manufacturer of motors and similar apparatus, to the effect that it is moving to another location, where it will have about 50,000 sq.ft. of production space and more machinery. This, it is stated, will enable the company to manufacture on a larger scale, increasing production several times over. The company expects to be located and operating by Feb. 1.

Pacific Coast Motor Pioneers Reorganized

The U. S. Electrical Manufacturing Company of Los Angeles has recently reorganized through the affiliation of the interests of H. G. Steele, formerly vice-president of the Pittsburgh Transformer Company, and C. E. Johnston of Los Angeles, Cal., vice-president of the U. S. Electrical Manufacturing Company. Mr. Steele, who is now the president of the U. S. Electrical Manufacturing Company, resigned from the Pittsburgh Transformer Company in the summer of 1919.

The U. S. Electrical Manufacturing Company, which is the pioneer manufacturer of electrical motors in the West, has been in existence for twelve years and now does a business of more than $2,000,000 annually. It is understood that plans for enlarging the business and the building of an additional factory are being made.

Star Brass Changes Name

In order that its name shall conform more nearly with the nature of its products, the Star Brass Works, 3114-26 Carroll Avenue, Chicago, manufacturer of spray cooling systems, painting and spraying machinery, has changed its designation to the Binks Spray Equipment Company, effective Jan. 1. Announcement is also made of the completion of a new plant and an office extension. Provision is made for new salesrooms, testing laboratories and increased manufacturing facilities.

Recommendations on Bluebird Claims

Receivers of the Bluebird Manufacturing Company, St. Louis, Mo., have filed a report in the Circuit Court in St. Louis showing the amount of claims against the corporation and making recommendations in regard to them. They recommend the allowance of claims totaling $839,777.22, referring to a special master another group of claims, totaling about $50,000, and the disallowance without prejudice of the claim of W. S. Ireland, former president of the company, for $4,603.87, based on expenses incurred by him in connection with the sale of the company to the Davis Sewing Machine Company of Dayton, Ohio.

One of the claims indorsed is that of J. B. Heydt for salary due him as an officer of the company. The receivers say that the salary should be paid with $2,154.50 in cash and the balance, $17,688.21, in preferred stock. The claim of James L. Coffield was reduced from $60,000 to $2,400.

The receivers report in favor of disallowing other claims amounting to approximately $78,000, including one of $73,659.18 by the Gardner Advertising Company, on the ground that they are not just. The receivers are J. H. Conrades, Benjamin Brinkman and Thomas Mellow. Henry A. Rosskopf was appointed by Judge Falkenhainer as special master in the case.

Universal Line to Go on Eight-Hour Day

Landers, Frary & Clark, manufacturers of the Universal line of electrical appliances and other metal lines, according to reports from New Britain, Conn., will operate on an eight-hour basis by the first of the year. Several departments, it is reported, have been operating on this schedule for a couple of weeks.

New Departure Wins Patent Suit

Decision has been handed down by Judge Garvin in the United States District Court granting a decree in favor of the New Departure Manufacturing Company, Bristol, Conn., in its suit against the Rockwell-Drake Corporation, the Marlin Rockwell Corporation and A. F. Rockwell, former president of the New Departure company. The court enjoined the defendants from manufacturing and selling double-row ball bearings which infringe and ordered it to render an accounting.

The validity of the patent was conceded, and the defendants admitted manufacturing the bearings covered by it. The issue was the construction of a contract claimed by the defendants as granting certain rights to manufacture the bearings in question. In deciding the case the court held that the contract was not violated.

Apex Prices Guaranteed to June 1

The Apex Appliance Company, Oakland, Cal., has announced that it will guarantee all dealers and customers against any decline in price up until June 1, 1921. Even then "it is problematical," the announcement reads, "if there will be any decline." This action is taken in order to impress upon the trade that there is no foundation for the prevailing opinion that Apex washer and ironer prices are coming down.

Westinghouse 1921 Fans Join All-Black Group

With its 1921 line the Westinghouse Electric & Manufacturing Company joins the group of manufacturers favoring the all-black fan. A dull-black finish for the blades and guards as well as the motor and base is the feature of the Westinghouse line. Previously the blades and guards were highly polished brass, coated with a transparent lacquer. The Westinghouse six-blade fans will be discontinued this year.

Otis Elevator Plants Operating Near Normal

Plants of the Otis Elevator Company, it is reported, are now being operated near normal on the accumulation of orders which were piled up earlier in the year when bookings were more than double plant capacity. For the past three months, it is understood, orders have been falling off, but the company is optimistic and believes that new construction cannot be held back in spite of declines in other markets.

Intermountain Electric's Annual Sales Convention

The annual sales convention of the Intermountain Electric Company was held at the Commercial Club, Salt Lake City, from Dec. 6 to 11 inclusive. One

of the features of the convention was a two-day series of demonstrations and lectures by representatives of the Westinghouse Electric & Manufacturing Company and the Westinghouse Lamp Company, known as the "Better Merchandising Shows."

Among the principal speakers at the convention were Lafayette Hanchett, president, and C. B. Hawley, vice-president and general manager of the Intermountain Electric Company. Factory representatives of a number of the large electrical and automobile accessory companies were in attendance at the convention. C. C. Campbell, sales manager, had charge of the program.

The Requa Electrical Supply Company, Rochester, N. Y., has increased its capital stock from $50,000 to $100,000.

The Wateree Electric Company, Jersey City, N. J., has filed notice of increase in capital stock from $7,500,000 to $30,000,000.

The Capital Lampagraph Company, St. Louis, is planning to remove its main offices to Chicago. It also contemplates establishing a new plant at Indiana Harbor, Ind. The company manufactures electric lighting equipment, electrically operated phonographs, etc.

The Louisville Electric Manufacturing Company, 660 South Second Street, Louisville, Ky., has awarded contract for the erection of a one-story plant, 60 ft. x 150 ft., for the manufacture of portable electric tools.

The Exide Battery Depots, Inc., 101 West End Avenue, New York City, a subsidiary of the Electric Storage Battery Company, Philadelphia, has filed plans for the erection of a two-story building at Spring and Clark Streets, to cost about $115,000.

The Tubular Woven Fabric Company, Pawtucket, R. I., will open a Pittsburgh office in charge of Gray Jones, formerly of the Cutler-Hammer Company. This is effective Jan. 1, 1921.

The Conveyors' Corporation of America, Chicago, announces the appointment of the Hallidie Machinery Company, L. C. Smith Building, Seattle, Wash., as its representative in Washington and Oregon. The Hallidie company is twenty years old. Philip Rowe is president, W. S. Dyson vice-president, Archie McLean secretary, and George Henderson treasurer.

The American Brass Products Company, Pottstown, Pa., has filed notice of increase in capital stock from $150,000 to $250,000.

The Howell Electric Motors Company, Howell, Mich., is planning to double the output of its plant within the next few months. The company recently increased its capital stock by $250,000.

The Rumsey Electric Company, 1007 Arch Street, Philadelphia, in celebration of its twenty-fifth birthday, has issued a thirty-two-page booklet showing by illustrations the officers and personnel of the company and the various departments of its organization.

The Frank H. Stewart Electric Company, Old Mint Building, 37-39 North Seventh Street, Philadelphia, has published a 667-page catalog, No. 22. Descriptions of the chief characteristics of the various articles listed are given as a feature of the publication of this twenty-five-year-old supply jobber.

Foreign Trade Notes

ELECTRIC HEATING IN AYLESBURY, ENGLAND.—The housing committee of the Borough of Aylesbury has decided that electrical heating apparatus shall be installed in the bedrooms of houses that are now being erected.

PROPOSED POWER DEVELOPMENT IN PUNJAB, INDIA. — Plans are under way for development of a hydro-electric plant in the chief centers of Punjab. The Punjab Hydro-Electric and Industries Association has been organized with headquarters at Delhi, and negotiations are under way for supplying electricity at Rawalpindi, Multan, Lyallpur, Jullundur, Sialkot and Gujranwala. The association contemplates developing electric power on four canal falls, to be operated as one system, which will supply electricity in considerable area of country north of the Chenab River.

PROPOSED HYDRO-ELECTRIC DEVELOPMENT IN PORTUGAL.—The Portuguese Minister of Commerce, it is reported, has appointed a commission to study the matter of utilizing the water powers of the rivers of Portugal for the purpose of furnishing hydro-electric power for railway, industrial and lighting purposes. The proposed project would involve an extensive system of dams, with a view to conserving water from the winter rainfall to last through the summer. Two engineers, Senhores Fernando de Souza and Vicente Riberio, have been nominated by the representatives of the Portuguese National Railways to sit with the commission.

BRITISH EXPORT REGISTER OUT.—The export register of the Federation of British Industries has been published by that federation, 39 St. James Street, London, S. W. Among the 650 pages are given the federation's constitution, aims, etc., list of members with their manufactures classified, and advertisements.

THE AMERICAN CHAMBER OF COMMERCE IN LONDON, 8 Waterloo Place, Pall Mall, London, S.W.1, England, has issued a year book of this chamber for 1920, in which are listed the names, addresses and business classification of more than 1,000 American and British firms, including electrical manufacturers, interested in developing business between the two countries.

ELECTRIC PLANT AT EVANS BAY, NEW ZEALAND.—The City Council of Wellington, New Zealand, contemplates a number of improvements, among which are the erection of an electric power station, tramway extensions, new car sheds and cars, to cost about £664,887.

DEMAND FOR ELECTRIC LIGHTING EQUIPMENT IN NETHERLANDS EAST INDIES.—Trade Commissioner John A. Fowler reports that there is a steady demand for electric lighting installations up to 40 kw. for estates, sugar factories, machine shops and other industries in the Netherlands East Indies. Small lighting sets of 50-lamp and 100-lamp capacity are also selling as rapidly as they can be imported for residences and the smaller plantations. Lists of engineering and machinery importing houses handling this business have been prepared and placed on file in Bureau of Foreign and Domestic Commerce.

WATER-POWER DEVELOPMENT IN NEW ZEALAND. — Tenders have been asked for equipment for the initial installation at the new hydro-electric generating station at Lake Monowai, Southland, New Zealand, consisting of two 3,000-kw. units, together with accessory equipment. The plans provide for an ultimate capacity of six 3,000-kw. units. A set of specifications, drawings and tender forms covering this installation has been placed on file for consultation at the New Yok office of the Bureau of Foreign and Domestic Commerce, Department of Commerce, 734 Custom House, New York City. A brief description of the equipment may be obtained from any of the bureau's district and co-operative offices by requesting circular FE-194.

ELECTRIC MANUFACTURING BUSINESS IN GERMANY.—A survey of the situation of the electric manufacturing industry in Germany recently made by a director of the Siemens-Schuchert Company, one of the largest electric engineering and construction firms in Germany, shows that in 1920 not more than 30 per cent of pre-war production of high-tension cables will be turned out. The condition in the wire, motor and installation industries is also bad. But few orders are being placed for power-plant equipment, the owners apparently being uneasy over the question of socialzation. In 1919, 70,000,000 marks' worth of lamps were produced. Before the war 50 per cent of Germany's production was exported, but at present less than 25 per cent is exported. Foreign competition, it is said, is much keener than before the war.

Foreign Trade Opportunities

Following are listed opportunities to enter foreign markets. Where the item is numbered further information can be obtained from the Bureau of Foreign and Domestic Commerce, Washington, by mentioning the number.

An engineering and trading company in India (No. 34,156) desires to be placed in communication with manufacturers of direct and semi-indirect lighting fixtures, switches, motors, farm-lighting plants, fans and heating appliances, etc.

An American residing in India (No. 34,162) desires to receive catalogs and approximate prices on Diesel oil engines of from 100 hp. to 1,500 hp. or more, both in two-cycle and four-cycle types, these to be considered for both industrial plant and central-station service.

The manager of a mercantile company in China (No. 34,164) is in the United States and desires to purchase and to secure an agency for the sale of electrical goods, etc.

The managing director of an engineering company in India (No. 34,168) desires to receive catalogs and general information for the purchase of modern electrical hospital equipment, both for electric treatment and for signaling, communication, etc., and also of electric passenger elevators.

A trading company in India (No. 34,171) desires to secure catalogs and quotations from manufacturers only of direct-current electric ceiling fans for 220 volts and 110 volts, and also of electrical novelties and toys.

New Apparatus and Publications

ELECTRIC FURNACE. — The Detroit (Mich.) Electric Furnace Company, issued a fourteen-page illustrated booklet describing its rocking electric brass furnace.

ELECTRIC FURNACE.—The Industrial Electric Furnace Company, Chicago, has published supplement C to bulletin 40, on repelling arc furnaces.

THERMOSTATIC METAL — The H. A. Wilson Company, 97 Chestnut Street, Newark, N. J., is circulating a book entitled "Wilco Thermostatic Metal," in which it describes the special process of the manufacture and the uses of thermostatic metal.

POWER TRANSMISSION.—The Baldwin Chain & Manufacturing Company, Worcester, Mass., has issued catalog F, covering its power transmission chains and sprockets, including roller chains, block chains, special chains, sprockets, etc. The company has issued bulletin No. 14, describing the selection of a chain drive and also bulletin No. 17, giving data on sprockets for roller and block chains.

POWER PLANT SPECIALTIES. — The Plant Engineering & Equipment Company, 192 Broadway, New York City, has issued a twenty-page catalog covering its "Peeco" specialties, including steam traps, separators, strainers, regulating devices, blowers, steam and electric pumps, meters, etc.

ELECTRICAL TESTING INSTRUMENTS. — "Hunting Down Electrical Troubles" is the title of a pamphlet issued by the Burton-Rogers Company, 755 Boylston Street, Boston, sales department for Hoyt electrical instruments, describing the use of the rotary meter, cell tester, cadmium meter and magneto tester in locating difficulties on storage-battery systems. The company has also issued a small pamphlet entitled "The Cadmium Test," describing in detail the reason and method of making the Cadmium test on storage batteries

ELECTRICAL INSTRUMENTS. — The Burton-Rogers Company, 755 Boylston Street, Boston, Mass., sales department for the Hoyt electrical instruments, has issued a catalog of Hoyt electrical instruments, including dashboard, miniature switchboard, large switchboard and portable instruments.

OILERS. — The Eagle Manufacturing Company, Wellsburg, W. Va., has issued catalog No. 20, covering its different types of oilers.

ELECTRIC ARC WELDING.—The U. S. Light & Heat Corporation, Niagara Falls, N. Y., has issued bulletin 700, entitled "Electric Arc Welding," in which it describes "USL" arc-welding machinery.

PORTABLE LAMPS.—The Empire Lamp & Brass Manufacturing Company, 426 South Clinton Street, Chicago, has issued catalog No. 60, in which it describes and illustrates its different types of portable electric lamps.

SMALL TURBO-GENERATOR SETS.—The General Electric Company, Schenectady, N. Y., has published bulletin No. 42,-010A, which supersedes bulletin No. 42,010, describing and illustrating the small Curtis steam-turbine generating sets. These generating sets have a capacity of 100 kw. to 300 kw. and are mounted on a common base with turbine and gearing.

New Incorporations

THE GREENVILLE (N. C.) STORAGE BATTERY COMPANY has been incorporated with a capital stock of $50,000 by W. G. Downing, W. T. Bryan and J. K. Proctor. The company proposes to manufacture storage batteries.

THE MARSHFIELD FARM ELECTRIC COMPANY, Marshfield, Wis., has been incorporated by R. T. Finucane, J. P. O'Connell and J. P. Adler. The company is capitalized at $20,000 and proposes to manufacture electric generating units and appurtenances for farms and isolated plants.

THE FENNIMORE (WIS.) PRAIRIE ELECTRIC & POWER COMPANY has been incorporated with a capital stock of $25,000 by R. M. Orchard, Anton Eisele and Emil Schwer.

THE SPRECHER MANUFACTURING COMPANY, Milwaukee, Wis., has been incorporated with a capital of $100,000 to manufacture lighting fixtures. The incorporators are R. J. Piehler, A. A. Sprecher and Peter W. Sprecher, proprietor of the Milwaukee Gas & Electric Fixture Company, 1910 Fond du Lac Avenue.

THE ADELPHI LIGHTING FIXTURE COMPANY, Brooklyn, N. Y., has been incorporated with a capital stock of $5,000 by L. Newman, J. Fenner and I. Barnett, 1379 St. John's Place, Brooklyn, N. Y.

THE WRANGELL MINING, PULP & POWER COMPANY, Wrangell, Alaska, has been incorporated by William D. Grant, Donald Sinclair and others. The company is capitalized at $1,000,000 and proposes to supply electricty for mining purposes.

THE INSTANTO ELECTRIC COMPANY, Maysville, Ky., has been incorporated with a capital stock of $25,000 by E. H. Knapp, Clement Finch and Andrew Clooney. The company proposes to manufacture electrical devices.

THE A. J. FELZ COMPANY, Boston, Mass., has been incorporated by S. Felz, Hyde Park; E. M. Dangel and Morris Linsky. The company is capitalized at $5,000 and proposes to manufacture electrical equipment and supplies.

THE GENERAL RESEARCH CORPORATION, Providence., R. I., has been incorporated by Patrick P. Curran, Henry C. Hart and Karl Farkas, 147 Wheeler Avenue, Cranston, R. I. The company is capitalized at $300,000 and proposes to manufacture electrical specialties.

THE E. A. KOENEMAN ELECTRIC COMPANY, East St. Louis, Ill., has been chartered with a capital stock of $20,000 by Charles C. Koeneman, C. H. Chapline and Albert G. Ziesk, 214 Collinsville Avenue, East St. Louis, Ill. The company proposes to manufacture electrical devices, etc.

THE NEW ENGLAND PRODUCTS COMPANY, INC., Mianus, Greenwich, Conn., has been incorporated with a capital stock of $300,000 to manufacture machinery, electrical equipment, etc. The incorporators are: H. L. Marsh, G. G. Knowles and C. F. Hoyt, 307 Atlantic Street, Stamford, Conn.

THE W. J. McNELLIS COMPANY, Waterbury, Conn., has been chartered by D. J. Stevens, J. J. and W. J. McNellis, 198 Grand Street, Waterbury. The company is capitalized at $75,000 and proposes to manufacture electrical equipment.

THE ELECTRIC POWER EQUIPMENT CORPORATION, Trenton, N. J., has been incorporated with a capital stock of $25,-000 to manufacture electrical equipment. F. W. Dinsmore, 709 Greenwood Avenue, is treasurer.

THE J. C. BOGGS MOTOR & LIGHT COMPANY, Lewisberg, W. Va., has been incorporated by J. C. Boggs, John A. Littlepage, Lewisberg, and W. A. Charleton, Hinton, W. Va. The company is capitalized at $50,000 and proposes to manufacture automobile lighting equipment and other accessories.

THE GOLD SEAL STORAGE BATTERY COMPANY, Green Bay, Wis., has been incorporated by F. J. Mankin, E. J. Bolza and T. J. Best. The company is capitalized at $300,000 and proposes to manufacture storage batteries.

THE WINNSBORO (TEX.) LIGHT & ICE COMPANY has been incorporated by Mrs. K. A. Campbell, R. C. Campbell and Mrs. J. W. Rhone. The company is capitalized at $60,000 and proposes to erect an electric light plant and ice factory.

Record of Electrical Patents

Notes on United States Patents

(Issued Dec. 7, 1920)

1,361,991. SYSTEM OF CONTROL; Rudolf E. Hellmund, Swissvale, Pa. App. filed Aug. 11, 1917. Railway-vehicle motors.

1,361,992. SYSTEM OF CONTROL; Rudolf E. Hellmund, Swissvale, Pa. App. filed Aug. 11, 1917. Electric railway vehicles.

1,361,993. SYSTEM OF CONTROL; Rudolf E. Hellmund, Swissvale, Pa. App. filed Sept. 7, 1917. Booster.

1,361,994. SYSTEM OF CONTROL; Rudolf E. Hellmund, Swissvale, Pa. App. filed Sept. 7, 1917. Electric railway vehicles.

1,361,995. SYSTEM OF CONTROL; Rudolf E. Hellmund, Swissvale, Pa. App. filed Oct. 13, 1917. Automatic regulation of electric-vehicle motors.

1,362,007. BRUSH HOLDER; Herbert G. Jungk, Pittsburgh, Pa. App. filed Oct. 8, 1917. Cannot move.

1,362,008. TELEPHONE RECEIVER; John C. Kane, Detroit, Mich. App. filed Oct. 21, 1919. Radio.

1,362,018. CELL POST AND METHOD OF MOUNTING SAME; Warren P. Loudon, Niagara Falls, N. Y. App. filed Jan. 26, 1918. Prevents escape of electrolyte.

1,362,020. TELEPHONE SYSTEM; Alben E. Lundell and Edgar H. Clark, New York, N. Y. App. filed Dec. 10, 1917. Automatic.

1,362,029. COMMUTATOR CYLINDER; Chester B. Mills, East McKeesport, Pa. App. filed Dec. 8, 1917. End connector.

1,362,049. EXPLOSION-PROOF DEVICE FOR ELECTRICAL APPARATUS; Charles W. Starker, Pittsburgh, Pa. App. filed Aug. 30, 1916. Pressure valve.

1,362,059. ELECTRIC CONDENSER; Philip Thomas, Edgewood Park, Pa. App. filed Sept. 28, 1917. Outer layers protected.

1,362,060. ELECTRIC HEATER; Frank Thornton, Jr., Mansfield, Ohio. App. filed June 29, 1918. Radiant.

1,362,072. MAGNETIC ORE SEPARATOR; Horace W. Arnold, Vancouver, Wash. App. filed Nov. 17, 1917. Drum type.

1,362,081. DOUBLE-FREQUENCY DISTRIBUTING SYSTEM; Lewis W. Chubb, Edgewood Park, Pa. App. filed Jan. 10, 1917. Over common mains.

1,362,082. MANUFACTURE OF COPPER PLATES FOR PROCESS PRINTING; Sherard O. Cowper-Coles, Sunbury-on-Thames, England. App. filed March 15, 1920. Electrolytic.

1,362,084. ELECTRICAL COMMUTATOR; Richard S. Dahl, Charlottenlund, Copenhagen, Denmark. App. filed Oct. 27, 1919. Core of insulating material.

1,362,096. TELEPHONE SYSTEM; Charles L. Goodrum, New York, N. Y. App. filed April 24, 1917. Telephone and telegraph messages transmitted simultaneously.

1,362,126. TELEPHONE SYSTEM; William H. Matthies, Hackensack, N. J. App. filed Feb. 20, 1917. Control of signaling.

1,362,138. INDUCTION COIL; Edward J. Pratt, New York, N. Y. App. filed Nov. 15, 1917. Repeating coil.

1,362,140. CARBON HOLDER; Harold D. Regar, Reading, Pa. App. filed Dec. 13, 1919. For use in arc lamps.

1,362,159. COMPOSITION FOR ELECTROLYTES FOR ELECTRICAL ETCHING; Joseph Henry Weeks, Rutledge, Pa. App. filed April 4, 1917. Formulas.

1,362,166. PROCESS FOR EXTRACTING ZINC FROM ORES; Frederick Laist, Anaconda, Mont. App. filed Jan. 5, 1920. From mixed ores.

1,362,206. ELECTROLIER STRUCTURE; Robert J. Ward, Philadelphia, Pa. App. filed Jan. 17, 1920. Ornamental fixture for connecting table lamps, vacuum cleaners, etc.

1,362,221. COMPENSATING WIRE SUPPORT; Charles C. Blackmore, Dayton, Ohio. App. filed June 7, 1918. Spring takes up slack on telephone line.

1,362,227. CIGAR LIGHTER; Dudley B. Clark, Bemus Point, N. Y. App. filed Aug. 6, 1920. Electrically heated.

1,362,289. STORAGE-BATTERY SEPARATOR; Daniel A. Grieb, Indianapolis, Ind. App. filed May 24, 1920. Slotted sheet.

1,362,294. ELECTRIC STORAGE BATTERY; Edward Hacking, Central Falls, R. I. App. filed Dec. 17, 1919. Lead plates and sulphuric acid.

1,362,295. ELECTROLYTE FOR ELECTRIC STORAGE BATTERIES; Edward Hacking, Central Falls, R. I. App. filed Dec. 17, 1919. Pumice combined with sulphuric acid.

1,362,301. MOTOR-CONTROL SYSTEM; Walter L. Hamilton, Holyoke, Mass. App. filed June 17, 1920. For paper-machine motors.

1,362,303. ELECTRIC INCANDESCENT LAMP; Francis Harrison, London, England. App. filed July 8, 1919. Means for placing the filament.

1,362,337. PROTECTIVE DEVICE; David T. May, New York, N. Y. App. filed Oct. 23, 1918. Telephone arrester.

1,362,349. NON-ARCING COMMUTATING-SWITCH DEVICE; Louis Paulero, Petersburg, Va. App. filed July 22, 1915. For electric hammers, etc.

1,362,351. ELECTRIC HEATING DEVICE; William A. Rankin, Chicago, Ill. App. filed Aug. 15, 1918. Ribbon adapted to be stitched.

1,362,356. INSTANTANEOUS ELECTRIC WATER HEATER; Louis J. Schneider, Milwaukee, Wis. App. filed March 15, 1920. Controllable by flow of water.

1,362,358. AUTOMATIC CONTROLLER CUT-OUT; Greer M. Shearer, Chicago, Ill. App. filed Feb. 17, 1917. For cranes, hoists, elevators, bridges, etc.

1,362,359. SEGREGATED DRIVE FOR PAPER MACHINES AND THE LIKE; Newton Shuttleworth, Rugby, England. App. filed Sept. 2, 1920. Sections run in fixed but adjustable-speed relationship.

1,362,375. WINDING FOR ELECTRICAL APPARATUS; Magnus Unger, Pittsfield, Mass. App. filed July 16, 1918. Oil will thoroughly permeate.

1,362,380. ELECTRICAL SYSTEM FOR AEROPLANES AND THE LIKE; Lionel M. Wolffsohn, Weehawken, N. J. App. filed March 13, 1917. Small weight.

1,362,383. APPARATUS FOR WIRELESS TELEGRAPHY AND TELEPHONY; William E. Beakes, New Orleans, La. App. filed April 19, 1919. Reduces effect of static.

1,362,386. IGNITION SYSTEM; Joseph Bijur, New York, N. Y. App. filed June 7, 1919. Hot ignition spark.

1,362,388. HIGH-TENSION INSULATOR; Francis O. Blackwell, Englewood, N. J. App. filed July 17, 1915. Suspension insulator.

1,362,432. FLASHLIGHT ATTACHMENT FOR FIREARMS; Cora M. Masters, Clarkton, N. C. App. filed Jan. 24, 1918. Hung below barrel.

1,362,452. MOTOR ATTACHMENT; Walter B. Uffert, Rochester, N. Y. App. filed Jan. 28, 1919. Automatically stopping when bearings become worn.

1,362,464. TELEPHONE ATTACHMENT; Charles Baum and Edgar H. Talbert, Washington, D. C. App. filed Oct. 10, 1917. Lever released by insertion of coin.

1,362,491. AUTOMATIC WELDING MACHINE; Otis A. Kenyon, New York, N. Y. App. filed Sept. 13, 1919. Feed mechanism.

1,362,492. VARIABLE-REACTANCE REACTOR; Friend H. Kierstead, Pittsfield, Mass. App. filed March 27, 1920. For controlling Birkland-Eyde arc furnace.

1,362,497. TURBINE-DRIVEN SET; William J. A. London, Springfield, Mass. App. filed Sept. 13, 1917. Short length.

1,362,543. DYNAMO-ELECTRIC MACHINE CONSTRUCTION; Adolph E. Seinceke, Cincinnati, Ohio. App. filed Feb. 3, 1917. Ending connection.

1,362,553. APPARATUS FOR CONTROLLING ELECTRIC CIRCUITS; Gustaf F. Bagge, New York, N. Y. App. filed May 15, 1915. Flasher sign.

1,362,554. STORAGE BATTERY; James Balzano, New York, N. Y. App. filed Nov. 20, 1919. Simultaneously charged and discharged.

1,362,574. LIGHT EXTINGUISHER FOR ARC LAMPS; Elmer A. Sperry, Brooklyn, N. Y. App. filed May 5, 1916. For preventing afterglow.

1,362,575. FEEDING MECHANISM FOR SEARCHLIGHTS; Elmer A. Sperry, Brooklyn, N. Y. App. filed Feb. 7, 1917. Electrode holders.

Construction News

Projects, Plans, Bids and Contracts, Contemplated or Under Way

New England States

BIDDEFORD, ME. — The Biddeford & Saco Water Company contemplates the expenditure of $30,000 for replacing steam power with electricity at the pumping station. Steam power will be used as an auxiliary.

MONROE, N. H.—The Grafton-Caledonia Power Company of this place contemplates the development of electric energy to supply Monroe and a number of other towns.

GROVELAND, MASS.—At a recent town meeting it was voted to appropriate $2,500 for improvements to the municipal electric system for additional service.

WAKEFIELD, MASS.—At a special town meeting it was voted to appropriate $25,000 for rebuilding the municipal light plant.

NEW BRITAIN, CONN.—It is reported that the power house at the woodworking plant of J. Pinches & Son, 67 Church Street, has been damaged by fire.

Middle Atlantic States

LONG BEACH, N. Y.—The village trustees have filed application with the State Public Service Commission for authority to establish a system for furnishing light. Bonds to the amount of $200,000 have been voted, and it is proposed to construct a power house and overhead distribution system.

BLOOMFIELD, N. J.—Scott & Bowne, 80 Orange Street, have plans under way for the construction of a power plant. An addition to their local cod liver oil factory is also contemplated. The total cost is estimated at $80,000.

PERTH AMBOY, N. J. — The Perth Amboy Dry Dock Company, foot of Broad Street, contemplates the installation of an improved floodlighting system and a general plant-lighting system to allow for operations during a twenty-four-hour period.

WEEHAWKEN, N. J. — The Cunard Steamship Company, 24 State Street, New York City, will defer awarding the contract for its proposed new freight terminal at this place. The project includes a number of piers and warehouses, a large central electric power plant and electrically operated equipment. The cost is estimated at about $30,000,000.

PECKVILLE, PA.—It is understood that the Scranton Coal Company, Scranton, has plans under way for the rebuilding of its power plant and coal washery at this place, reported to have been recently destroyed by fire, causing a loss of about $250,000.

PHILADELPHIA, PA.—Plans have been filed by the Standard Engineering Company, Thirtieth Street, for the erection of a power house, 24 ft. x 35 ft. x 60 ft.

READING, PA. — Arrangements have been made by the Metropolitan Edison Company for a bond issue of $100,000, the proceeds to be used for plant extensions and betterments.

SCRANTON, PA.—The Delaware, Lackawanna & Western Railroad Company, Hoboken, N. J., is considering the erection of a large power station in Scranton and the electrification of pusher engines for service between this place and the summits, east and west of the city.

MARTINSBURG, W. VA. — Plans are under way for the rebuilding of the switchboard department of the Potomac Light & Power Company, recently destroyed by fire, causing a loss of about $20,000.

WINCHESTER, VA.—The Front Royal-Riverton Milling Corporation, Riverton, contemplates the erection of a dam across the Shenandoah River, for power development.

WASHINGTON, D. C.—According to report being prepared by Major M. C. Tyler, in charge of the local engineer office, the development of 45,000-kw. to 50,000 kw. from Great Falls is possible. Major Tyler's estimate also includes the erection of high-tension transmission lines and three substations in connection with this project.

North Central States

BLISSFIELD, MICH.—A special election will be held on Jan. 11 for the purpose of submitting to the voters a proposition to issue bonds to the amount of $30,000 for improving the electric light plant.

GRAND RAPIDS, MICH. — The Consumers' Power Company contemplates the erection of an addition to its power house to cost about $400,000. G. L. Erwin is manager.

KINDE, MICH.—The Central Light & Power Company, Bad Axe, is planning to furnish electrical service to this village.

OTSEGO, MICH. — The MacSim-Bar Paper Company, A. B. Thomas, president and general manager, is having preliminary plans prepared for the erection of a power plant. B. M. Baxter, Merian Building, Cleveland, Ohio, is structural and mechanical engineer.

TIPPECANOE, IND. — An organization to be incorporated as the Tippecanoe Power Company with a capital stock of $3,000,000 plans to begin work in the spring on the construction of dams and power units along the Tippecanoe River to develop current for several of the larger towns in northern Indiana. Surveys have been made and preliminary plans prepared by J. A. Shafer, engineer, 310 Odd Fellows' Building, Indianapolis.

ANTIGO, WIS.—The city officials contemplate the installation of an ornamental street-lighting system to include forty-six standards. G. O. Palmiter is city clerk.

TAYCHEEDAH, WIS.—Bids will be received by the State Board of Control, Madison, until Jan. 11, for furnishing for the Industrial Home for Women at this place equipment including two 50-kw. direct-connected, engine-type, 230-volt generating sets with duplicate balancer sets of 10 kw. each; switchboard and distribution system; two 600-hp. open-type feed-water heaters; two turbine-driven centrifugal circulating pumps, 300 g.p.m., 150-ft. head, or two direct-acting steam pumps, same service, etc. A Peabody, Capitol, Madison, is engineer.

SWIFT FALLS, MINN.—The city officials contemplate the development of water power at this place. The cost is estimated at $40,000. W. E. Skinner, 15 South Fifteenth Street, Minneapolis, is engineer.

THOMSON, MINN.—The Duluth Edison Electric Company of Duluth has made petition for right-of-way for the construction of a transmission line from the power plant of the Great Northern Power Company at this place to Duluth. It is proposed to erect the new line in the spring.

NEVADA, IOWA.—The Iowa Light & Power Company contemplates the erection of an independent electric plant in this city.

JOPLIN, MO.—The Empire District Electric Company, 414 Joplin Street, has been authorized to issue bonds to the amount of $1,725,000 under its first mortgage, the proceeds to be used for extensive improvements to its plant.

LEXINGTON, MO.—The Missouri Gas & Electric Service Company contemplates improvements to its plants at Richmond, Liberty, Orrick and Lexington.

ST. JOSEPH, MO.—The City Council and W. K. Seitz, city engineer, are making investigations as to the possibilities for securing electrical energy from Kansas City for this place. The estimated cost of the erection of a line direct to St. Joseph is $500,000. E. M. Lindsay is president of the council.

MOUND VALLEY, KAN.—Bonds to the amount of $25,000 have been voted for electrical improvements in the city. W. B. Rollins & Company, 210 Railway Exchange Building, Kansas City, Mo., are engineers.

Southern States

DURHAM, N. C.—The Southern Power Company, general office at 511 Fifth Avenue, New York City, has filed notice of $4,000,000 increase in capital for general expansion.

RALEIGH, N. C.—The Carolina Power & Light Company plans to make additions to its plant connected with the operation of the street railway. The cost is estimated at $51,600.

WINSTON-SALEM, N. C. — The street-lighting committee of the Chamber of Commerce has launched a campaign for the raising of $20,000 for an ornamental street-lighting system.

TYBEE, GA.—Bids will be received by the Bureau of Yards and Docks, Navy Department, Washington, D. C., until Jan. 12 for the erection of a radio building at Tybee Island.

GALLATIN, TENN.—The City Council of Gallatin is negotiating with the Union Traction Company of Nashville for furnishing this place with power. Plans include the erection of an 18-mile transmission line and the construction of a substation at some point between the two cities. The present power station at Gallatin is inadequate to meet the needs of the city but will be retained for emergency.

AMORY, MISS.—The City Commission contemplates the erection of an electric light and water plant, for which bonds have been issued.

Pacific and Mountain States

SEATTLE, WASH.—Bids will be received by H. Carroll, city comptroller, until Jan. 3 for the purchase of $1,005,000 municipal light and power plant bonds of 1919, Series No. 2, and $1,000,000 of 1918, Series K. The proceeds from the sale of the first issue above referred to will be used for the installation of 20,000 hp. of additional machinery, penstocks and equipment at the Cedar River hydro-electric plant; for receiving transformers for this power to be used in Seattle, etc. The proceeds of the second issue will provide for a transmission line and receiving station in Seattle, in connection with the Skagit River project.

SEATTLE, WASH.—The Great Northern Railroad, King Street, has had plans prepared by Robert Herzog Company, engineers, for the erection of a fuel-oil plant for the generation of additional electric power.

ASTORIA, ORE.—Bids will be received by the Bureau of Yards and Docks, Navy Department, Washington, D. C., until Jan. 5 for the erection of a radio building at this place.

LOS ANGELES, CAL.—Bids will be received by the Department of Public Service until Jan. 18 for furnishing distribution and small power transformers. J. P. Vroman is secretary.

LOS ANGELES, CAL. — Announcement has been made by J. B. Miller, president of the Southern California Edison Company, that the Federal Power Commission has accepted its application for a preliminary permit to develop 2,500,000 hp. of electrical energy from the waters of the Colorado River. According to Mr. Miller the total possible hydro-electric development of the river is more than 4,000,000 hp.

MODESTO, CAL.—W. I. Carpenter, city electrician, and G. Freitas, city engineer, have been appointed by Mayor Ulrich to investigate the possibilities of Modesto generating its own electric power.

PASADENA, CAL.—The City Commission is considering the erection of a dam in San Gabriel with a power plant in Eaton's Canyon for an increase in the capacity of the water supply.

AMERICAN FORK, UTAH.—Estimates and plans are being prepared covering the cost of improvements to the street-lighting system.

AMMON, IDAHO.—The Utah Power & Light Company, Salt Lake City, Utah, has been granted a fifty-year franchise covering the right to maintain and operate electric light and power lines in this village.

STAR, IDAHO.—A delegation of farmers consulted the Public Utilities Commission as to the necessary steps to take to have a transmission line erected between this place and Nampo, a distance of 5 miles.

Canada

BRANTFORD, ONT.—Announcement has been made by Chairman Wedlake of the Hydro-Electric Commission of this place that the power house on Greenwich Street will be extended for the installation of duplicate equipment for increased service.

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